JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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FOR THE YEAR

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Royal Microscopical Society.

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The Society was established for the communication and discussion of observations and discoveries (1) tending to improvements in the construction and mode of application of the Microscope, or (2) relating to Biological or other subjects of Microscopical Research.

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PREFACE.

This Journal has now completed the tenth year of its publication, since it was launched on the extended basis which was inaugurated after its first year, when it formed a volume of 402 pages only.

Throughout this period I have had no reason to complain of any want of appreciation, but on the contrary have to acknowledge a veritable load of congratulations of a very demonstrative character, not only from microscopists but from biologists generally who have recognized the value of a publication—the only one in the English language—which enables its readers to make themselves acquainted without delay with the contents of the enormously scattered literature of Biology and Microscopy throughout the world. It is the fact of this consensus of opinion that leads me to add this Preface to the present volume, as the approbation that has been showered on the Journal has not fully reached those who are most worthy of it.

In the case of a battle, it is perhaps necessary that it should pass as the victory of the particular general in command, however much it may have been due to the skilful arrangements of the commanders of divisions or to the general valour of the rank and file, but we are not trammelled by any such rules in the case of this Journal, and it is proper therefore to call attention to the extent to which its success is due to my Co-editors.

In the departments of Botany and Zoology, Mr. A. W. Bennett and Prof. F. Jeffrey Bell have now for nearly ten years analysed the various papers which have been recorded in the Summary of Current Researches. No one who has not actually undertaken it can have any idea of the extent of the labour which this involves. My own preliminary work in advance of the actual analyses has required a certain amount of resolution to face week after week, but this labour has been very small in comparison with that undertaken by Mr. Bennett and Prof. Bell, who have had to read through the whole of the papers and then to produce those analyses which have appeared in number after number. Moreover, the length of the notes is practically in inverse proportion to the difficulty of writing them. It is easy to produce an extended abstract;

the difficulty is to condense the leading ideas of the author into a brief compass, so that any one who desires to know its scope, and to determine whether it is desirable to refer to the original paper, can have before him the necessary guidance. All this has been done by Mr. Bennett and Prof. Bell, with an amount of skill and with a degree of regularity which at the outset I should hardly have believed possible. What is still more remarkable, is the punctuality which has been observed throughout. In no single instance has the MS. been received after the appointed time; in most cases it has been in advance of time. A striking testimony to what has thus been accomplished is to be found in the view of an eminent biologist, who, in the earlier days of the Journal expressed the opinion that the Summary must necessarily in a short time "run thin": the same biologist last year spontaneously declared that "the Journal got better and better." I claim therefore for Mr. Bennett and Prof. Bell that botanists and zoologists owe them a large debt of gratitude for the good work they have done with so much self-sacrificing perseverance.

The Microscopical division of the Journal is in like manner greatly indebted to Mr. J. Mayall, jun., for a large amount of assistance which for the same length of time he has rendered in this department; assistance of such a character that without it it would have been impossible to produce the varied assortment of matter which has kept microscopists so fully informed as to all that is novel, interesting, or curious in the various sections of the subject.

I have left unnoticed the services of Mr. J. Arthur Thomson, who has recently undertaken, with no little success, a part of the Zoology, and of Dr. Hebb, who has practically had complete charge of the Technique section, with what result the pages of the last two volumes of the Journal abundantly show. This omission arises from the fact that I have been dealing not only with the quality of the services rendered by the three senior Co-editors, but also with the remarkable length of time over which those services have extended, and in which respect they at present stand alone.

It is to be hoped that the increased circulation of the Journal outside the Society may allow of some adequate return in a substantial form being made to the Co-editors, and, meantime, I tender to them not merely my own thanks but those of the Fellows of the Society at large, and I hope and believe those of a still wider circle of biologists and microscopists also.

Frank Crisp.

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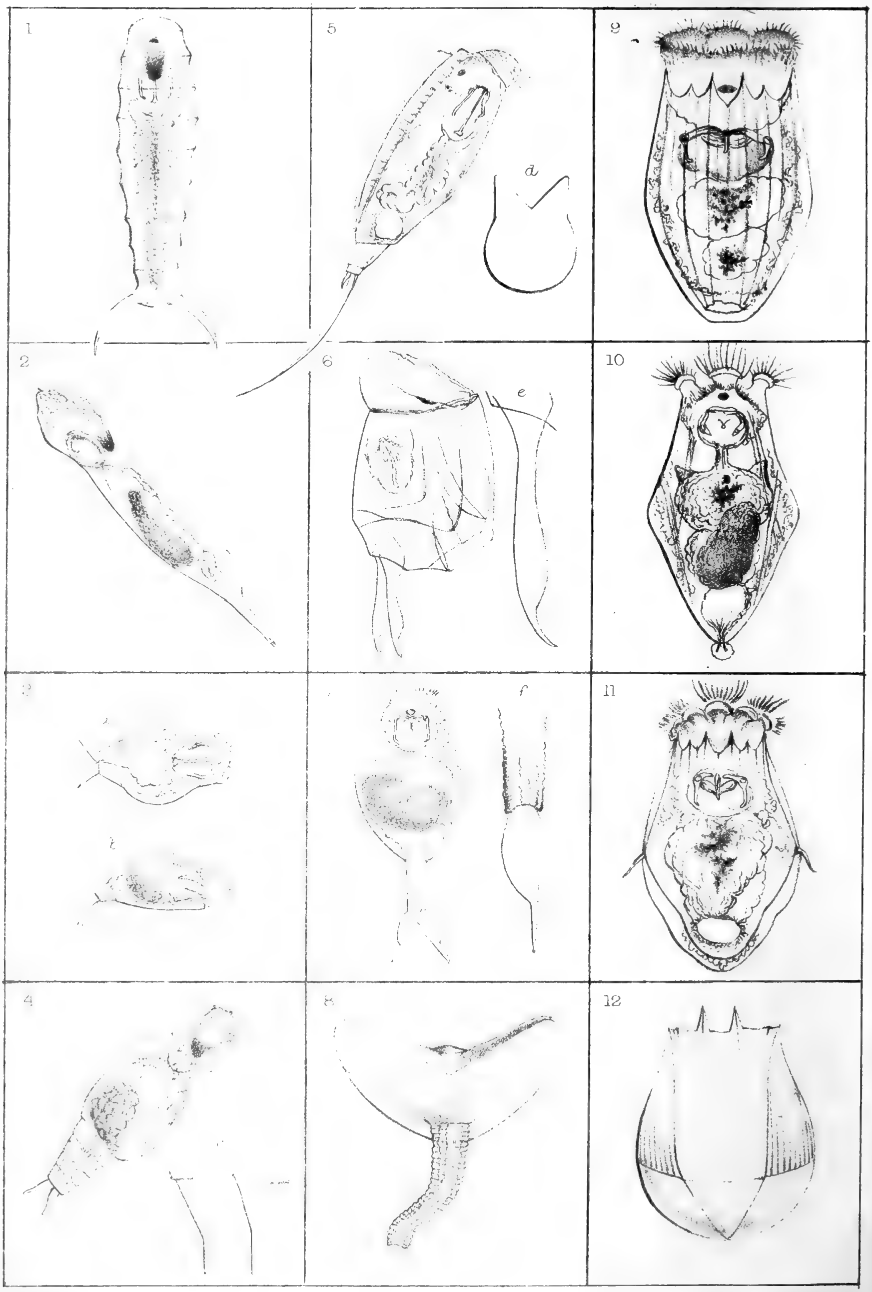

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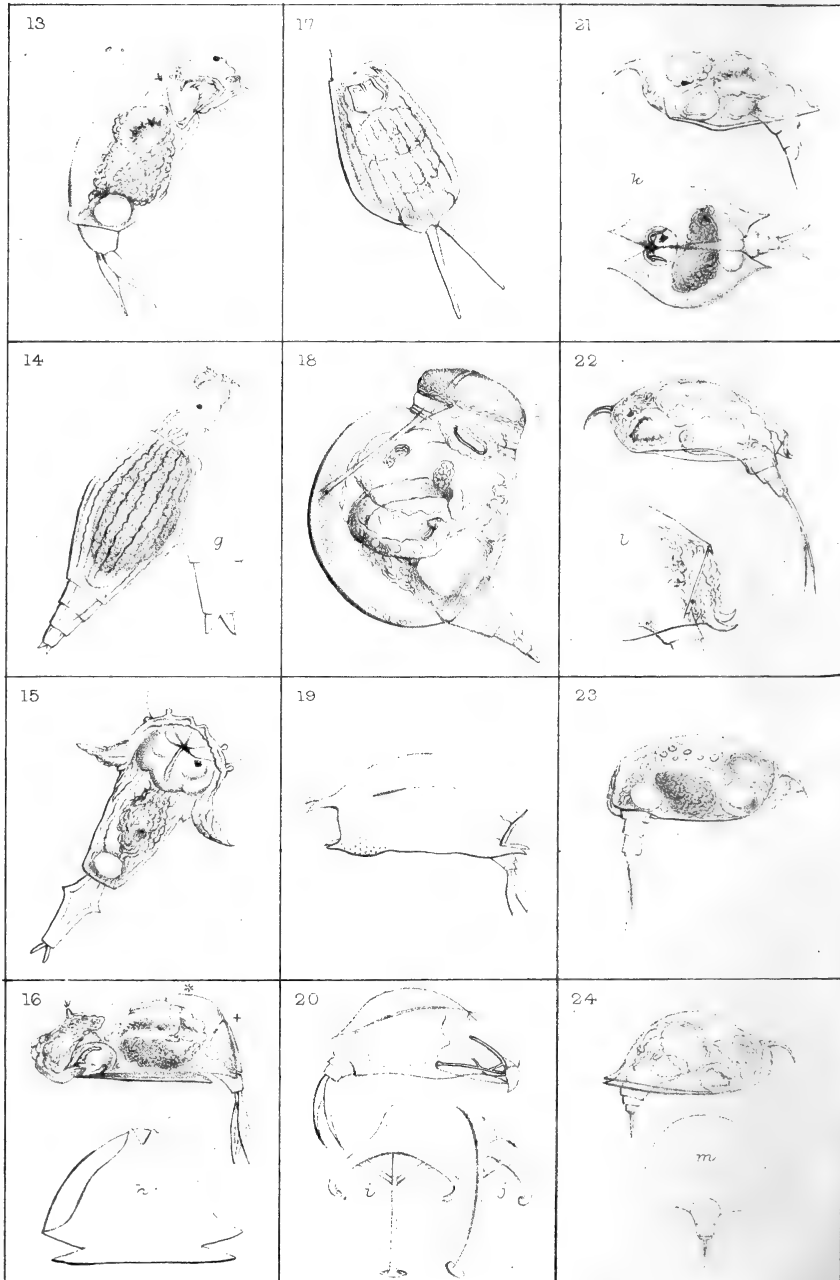
New Rotifera.



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New Rotifera.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1887.

TRANSACTIONS OF THE SOCIETY.

I.—*Twenty-four New Species of Rotifera.*

By P. H. Gosse, F.R.S., Hon. F.R.M.S., &c.

(*Read 8th December*, 1886.)

Plates I. and II.

The following species of Rotifera were discovered either too late to be included in Dr. Hudson's work, or since that work was published. They are described with brevity; but, I hope, with precision sufficient for identification and differentiation.

1. *Taphrocampa selenura.* Body thick towards the head, tapering towards the foot; marked with strong articulations like *T. annulosa*; brain opaque, with a distinct red eye on its inner side; caudal fork a wide crescent; trophi as in *Notommata aurita.* Length 1/100 in. Lacustrine.

Since the note in H. and G. Rotif., i. 17, I have made repeated

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EXPLANATION OF PLATES I. and II.

Fig. 1.—*Taphrocampa selenura*; dorsal.
„ 2.—*Diglena* (?) *silpha*; lateral.
„ 3.—*Notommata ovulum*; *a*, dorsal; *b*, lateral.
„ 4.—*Furcularia melandocus*; dorsal; *c*, toes, enlarged.
„ 5.—*Mastigocerca bicristata*; lateral; *d*, ideal section.
„ 6.—*Diaschiza* (?) *cupha*; lateral; *e*, one toe, enlarged.
„ 7.—*Mytilia Teresa*; dorsal; *f*, one toe, enlarged.
„ 8.—*Pterodina reflexa*; posterior.
„ 9.—*Notholca jugosa*; dorsal.
„ 10.— „ *rhomboidea*; dorsal.
„ 11.— „ *spinifera*; dorsal.
„ 12.— „ *polygona*; dorsal.
„ 13.—*Furcularia lophyra*; lateral.
„ 14.—*Callidina pigra*; dorsal; *g*, spurs, enlarged.
„ 15.—*Synchæta longipes*; dorsal.
„ 16.—*Euchlanis oropha*; lateral; *h*, transverse sections, the outer at *, the inner at †, of upper figure.
„ 17.—*Distyla striata*; dorsal.
„ 18.—*Asplanchna eupoda*; lateral.
„ 19.—*Salpina marina* (lorica); lateral.
„ 20.—*Diaschiza* (?) *rhamphigera*; lateral; *i*, trophi, dorsal; *j*, lateral.
„ 21.—*Colurus Dumnonius*; lateral; *k*, ventral.
„ 22.— „ *dicentrus*; lateral; *l*, termination of body.
„ 23.— „ *grallator*; lateral.
„ 24.—*Monura micromela*; lateral; *m*, posterior.

examinations of this form, which, I am now convinced, has specific value. The crescent behind is glassy clear throughout, continuous with the body, not articulated; its form is that of the new moon when first visible. Cf. *Balatro clavus* Clap. (Plate I. fig. 1.)

2. *Diglena* (?) *silpha.* Body sub-cylindric, stouter at the head, abruptly lessened behind; brain saccate, long, opaque at the end; toes minute, conical. Length 1/100 in. Lacustrine.

The whole animal is very soft and plump, not wrinkled, even in retraction. A well-marked, soft, decurved proboscis is on the front: no eye is visible. The sudden attenuation of the body to a slender cylinder, one-fourth of the whole length, is remarkable; this terminates in two or three soft lobes, below which are two very minute toes, with no appreciable foot intervening; for the rectum can be traced to a cloaca, just above the toes. Fuller examination is needed: I have seen but a single example, sent from the middle of Ireland; and the trophi were not satisfactorily defined. (Fig. 2.) Cf. *Notommata forcipata,* lat. aspect.

3. *Notommata ovulum.* Very small; body globose, plump; dorsum gibbous; venter flat: brain clear; eye wanting: foot short; toes rather long, acute, decurved. Length 1/370 in. Lacustrine.

This attractive little form has so much resemblance to *N. lacinulata,* that I had doubted whether it is not a *var.* of that species. There are, however, divergences, important, if minute. It is very much rounder in all aspects; the toes are longer, uniformly diminishing to acute points, and decidedly decurved: no trace of eye could be discerned. It swims rapidly, but evenly; does not *spring,* and does not *twitch*;—both which actions are so characteristic of *lacinulata.* Auricles (?) are occasionally pushed out. The front projects in a tubercle, halfway between which and the auricle on each side is a stiff seta. I have examined three specimens, two from Woolston, and one from Dundee. (Fig. 3.)

4. *Furcularia melandocus.* Body swollen, obtusely narrowed in front, tapering behind: brain saccate, opaque at the extremity: foot large; toes conical, each terminating in a soft, slender point, much produced. Length 1/130 in. Lacustrine.

Of excessively versatile outline, rapidly lengthening and shortening every instant. The front is apparently hard, with a sharp edge, below which is a broad, sub-prone, ciliate face. An ample brain-sac,—its terminal portion filled with chalky deposit, usually intensely black by transmitted light, but in some examples much diluted,—looks like a bottle of ink swaying to and fro in the animal's contortions. The prolonged finger-like tips of the toes (*c*) have a strong adhesive power, dependent on a pair of great mucus-glands. A minute frontal eye is not *quite* certain. Several examples have occurred in water from Woolston. (Fig. 4.)

5. *Mastigocerca bicristata.* Two equal sub-parallel carinæ, running nearly the whole length of the dorsum. Length 1/50 in., of which the toe is nearly half. Lacustrine.

Discovered near Dundee, by Mr. Hood, who sent me from time to time many examples. It has a general likeness to *M. carinata,* but is much larger. The double carina confirms the conjecture that the asymmetry of that and other species is due to unequal development.

The carinæ are thick at their base, and sharp at their edge, so that the furrow is sharp at the bottom, and has sloping sides. (Fig. 5: *d*, ideal section.)

6. *Diaschiza* (?) *cupha*. Much compressed; dorsum squarely gibbous: foot short, scarcely protruding; toes long, blade-shaped, slightly recurved, with claws abruptly shouldered. Length 1/124 in. Lacustrine.

This hunch-backed form needs fuller examination. I describe it from a single example, just dead, but not decomposed, in water sent from Birmingham. The depth, compared with the width, of the animal is remarkable. The trophi were very long, but ill-defined: in the occiput is a short brain, carrying a flat, lens-shaped red eye on its inner surface. The peculiar shape of the toes is shown at *e*. I affix a mark of doubt to the *generic* position, because I could not be *quite* sure of the dorsal cleft. (Fig. 6.)

7. *Mytilia Teresa*. Body truly oval: toes together wider than foot; each toe large, long, ovate, abruptly produced to a long, slender, acute point. Length 1/200 in. Marine.

This very pleasing species I have found in some abundance, in water dipped for me out of tide-pools in various parts of Torbay by my little granddaughter, with whose name I honour it. It has a very distinct red eye in the occiput. The large bulbous toes are peculiar, of which one is shown laterally at *f*. It is a sprightly creature, playing actively among confervoid algæ, often pivoting on its toes, like a *Cathypna*, jerking and bowing: it is less locomotive than *M. Tavina*. (Fig. 7.)

8. *Pterodina reflexa*. Lorica elliptical in outline, the two longitudinal halves bent upward and backward, at a considerable angle; the dorsal surface being evenly furrowed, the ventral rounded. Length of lorica 1/220 in. Lacustrine.

The angular character is not noticed on a dorsal view, but becomes conspicuous in the act of turning. *P. valvata* bends its leaves *downward*, on hinges, at will. *P. reflexa* bends its halves *upward*, on a medial line which is not hinged, but permanent. It is somewhat like a butterfly, sitting, with half-opened wings, on a flower in an autumn noon. The internal structure is normal. I have found it abundant in water from Smallheath, Birmingham. (Fig. 8.)

9. *Notholca jugosa*. Lorica ovato-rhomboid, highly elevated, broadly truncate before, narrowly behind: ridges and furrows strongly marked, ending before they reach the hind margin. Length 1/190 to 1/130 in. Marine.

This, of all the *Notholcæ*, seems to come the nearest to Ehrenberg's figure of *Anuræa striata*; of which he says, it is marine at Copenhagen, associating with *Pter. clypeata* and *Brach. Mülleri*, species with which *jugosa* is commonly found in the tide-pools of the Firth of Tay and of the Devon coast. (Fig. 9.)

10. *Notholca rhomboidea*. Lorica rhomboidal, with the lateral angles rounded, the front produced and truncate; dorsal and ventral plates separated behind by a short cleft. Length 1/160 to 1/145 in. Marine.

The ridges, in this species, can with difficulty be discerned, especially as the rotating head is habitually protruded, which the creature does not retract for the shock of any tap or shake of the instrument that I

can give. There is a long wrinkled œsophagus, a great saccate stomach, a distinct intestine, with the cloaca at the very extremity of the lorica: the branchial bands are distinct, but no contractile vesicle. It is not uncommon, with the preceding. (Fig. 10.)

11. *Notholca spinifera.* Lorica broadly sub-rhomboidal; the dorsal plate often less than the ventral, and separated by a wide and deep cleft: at each angle of junction is seated a short spine, so hinged as to be concealed within the cleft, or widely projected, at will. Length of lorica 1/220 to 1/100 in. Marine.

An interesting and attractive species. The whole interior is often richly coloured, especially the enormous stomach. An ample contractile vesicle is present. The hind outline in some examples is evenly rounded; in others an inangulation marks both plates. Ehrenberg's figure of *Anur. biremis* may be compared with this; but it differs in important details; and his text gives no help. I receive this also from the Tay tide-pools. (Fig. 11.)

12. *Notholca polygona.* Lorica roundly pear-shaped, truncate in front; the central pair of the occipital spines stout, the other two pairs almost obsolete: ventral plate forming a square box, with sloping, many-angled sides. Length 1/160 in. Lacustrine.

A remarkable form. The dorsal plate is a half-oval, the ventral nearly flat. The latter is very peculiar: a kind of sub-cubic box, open at the summit, runs down to about three-fourths' length, and then proceeds, in pyramidal form, to a point at bottom; and this appears to contain the viscera. Each side is covered-in by a plate of two planes, but appears to be empty. On those parts of the arched dorsal plate which answer to these empty lateral chambers, run down very delicate flutings, while the broad medial part is quite clear and smooth. All the angles are distinct. The only example seen was dead, but showed a crimson eye and a normal mastax. From Kingswood Pool, near Birmingham. (Fig. 12.)

13. *Furcularia lophyra.* Body fusiform: head separated by a constriction; back sharply ridged; toes broad at base, tapering at mid-length to long-drawn fine points. Length 1/290 to 1/260 in. Lacustrine.

Somewhat near to *F. gracilis*, but the above characters, which are constant in a great number of examples, sufficiently distinguish it. The body, sub-cylindric at first, swells more or less behind the middle, where the dorsum rises to a sharp edge, *not a carina.* The head is large, always distinct, with a brilliant eye at the very front, and a prone ciliate face. The trophi are those of *gracilis*, very large, often extruded. A thick short foot bears two great toes, often widely expanded, one-fourth of the whole length; each is a glassy rod, of thick base, which tapers somewhat abruptly near the middle to a long point of great tenuity. (Plate II. fig. 13.)

14. *Callidina pigra.* Body fusiform, fluted, not collared; column having a decurved acute hook; spurs minute; viscera rufous. Length (extended as in fig.) 1/90 in. Lacustrine.

I have seen two examples, both of which had the extremities colourless, but the middle tinged of a delicate sherry-brown, the viscera

somewhat deeper in hue; while in one was an immense egg, of a coffee-brown, almost opaque, whose appearance suggested the probability that the species is strictly oviparous. The acute hooked proboscis is very conspicuous. The corona, scarcely divided, is not wider than the neck at the antenna, and this neck is not swollen into a collar. The penultimate spurs are very minute cones, whose bases are not separated by an interspace (fig. 14, *g*). The whole central body is indented with longitudinal furrows. The mallei are destitute of visible teeth. (Fig. 14.)

The animal is remarkably sluggish, rarely swimming, but turning its head slowly and aimlessly from side to side. It has occurred in Woolston Pond.

15. *Synchæta longipes.* In front much like *S. pectinata,* but with the foot distinct, separated, long, furnished with two small toes. Length 1/173 in. Lacustrine.

The well-marked foot, having a rhomboid outline, common to all the eight or ten specimens that I examined, appeared to me sufficient, when combined with its small dimensions, to distinguish this species from *S. pectinata,* with which else it has much in common. The broad head bears four frontal warts and two setæ. It has occurred in some profusion in fresh water near Dundee. (Fig. 15.)

16. *Euchlanis oropha.* Lorica roof-shaped with sloping sides, but not rising to a ridge, yet cleft for a short distance behind, between two descending extremities. Ventral plate flat, thin, much smaller in its whole outline than the carapace: foot with a single seta or none; toes thin, blade-shaped. Length, total, 1/75 in. Lacustrine.

This is a noble species, and not uncommon. The posterior fourth of the ovate lorica seems as if pinched-in, and the dorsal edge *of this portion* becomes a low double carina. In fig. 16, *h,* the inner outline is that of this portion (posterior to † in the upper figure), the outer outline represents a transverse section at * in the upper figure. (Fig. 16.)

17. *Distyla striata.* Lorica as in *D. Gissensis,* but covered with longitudinal sulci; the front margin projecting in two lateral points (which, however, are lost in the protrusion of the head, by the evolution of flexible membrane): toes slender, straight, more than half as long as lorica, pointed, not shouldered. Length 1/130 in. Lacustrine.

The lateral infold is narrow and nearly closed. The dorsal sulci are about eight in number, slender and superficial: foot a long large bulb, not divisible into joints; toes long, nearly straight, rods. The dorsal surface is corrugated, besides the sulci; there is a minute eye, difficult of detection. Two examples occurred in water sent me by Dr. F. Collins from the pool at Sandhurst Military College. (Fig. 17.)

18. *Asplanchna eupoda.* Body globose, with a stout foot, retractile at will: rami of incus long, each armed on its inner edge with four widely-severed teeth. Length, moderately extended, 1/52 in., width 1/118 in. Lacustrine.

The most remarkable feature is the foot, which is, proportionally, much larger than in *A. myrmeleo.* The pincer-like rami are those of a normal *Asplanchna,* having a close resemblance to those of *A. priodonta,* save that their inner edges are not cut into saw-teeth, but beset with three distant spinous teeth, while each curved point is double. I have

examined eight or ten examples, all from the canal, Smallheath, Birmingham. (Fig. 18.)

19. *Salpina marina.* Occipital spines two, procurved; pectoral two, short; lumbar spine short, deep; alvines stout, separated from the lumbar by an angular sulcus. Length of lorica, from points to points, 1/136 in. Marine.

This large species was taken in a tide-pool in the Firth of Tay; the first *Salpina* found in the sea. Its anterior armature is that of *S. mucronata*, but the posterior is peculiar, in that the alvines are stout, nearly straight spines, and that the sinus which divides each from the lumbar point is not rounded, but makes two sides of a rhomboid, with definite angles. The specimen was dead when I found it. (Fig. 19.)

20. *Diaschiza* (?) *rhamphigera.* Lorica elliptical in outline, viewed dorsally; highly gibbous, viewed laterally; venter flat: toes stout, long, decurved: trophi projecting in form of a bird's beak. Length 1/173 in. Lacustrine.

The front terminates in an acute hooked beak, which is found to be the extremity of the trophi, and apparently of the incus protruded. The whole manducatory apparatus is of unusual dimensions, especially the fulcrum of the incus. (Fig. 20, *i*, represents the trophi seen dorsally; *j*, laterally.) I have not distinctly seen the dorsal cleft; but the line which passes along the back, at some distance from the edge, I presume to indicate the bottom of such a cleft; if it is not the base of a high carina. Two examples occurred together in water from one of my window tanks. (Fig. 20.)

21. *Colurus Dumnonius.* Lorica in dorsal aspect a very broad oval, produced behind into two rather short points, separated by a wide but shallow sinus: the ventral line deepens in the middle; the ventral cleft extends around the front to the occiput: foot robust, with two moderately stout, separable toes. Length 1/260 in. Marine.

Three examples I have seen at different times among fine conferva, much studded with *Licmophoreæ*, from tide-pools at Paignton, near Torquay. One of these had the sides much more parallel than the others. A large pale red eye is conspicuous. All had the habit of pivoting on the toe-tips, jerking and posturing. (Fig. 21.)

22. *Colurus dicentrus.* Lorica ovato-fusiform: body ending behind in a minute tail of two hooks adnate at their base: foot stout; toes long, very slender, more or less decurved throughout. Length 1/185 in. Marine.

I have examined nearly a score of individuals, and am satisfied that this is a true species, in which the peculiar termination of the body (shown enlarged in fig. 22, *l*) is constant, thus differing from *C. amblytelus* and *C. grallator*. The tail-points resemble rose-prickles. The appressed toes seem a single slender spine, but are often thrown apart. Two red eyes are distinct. It is not rare in the Tay tide-pools. (Fig. 22.)

23. *Colurus grallator.* Lorica much compressed; lateral outline ovate, sub-square behind, without points: toes half as long as lorica, very slender, straight, readily separated: ventral cleft slightly narrowed in the middle. Length 1/250 in. Marine.

Nearly related to the preceding; but the outline, viewed dorsally, is longer and narrower; there is no protrusion of the body behind the lorica; and the toes are quite straight. The frontal hook is unusually narrow. I have not been sure of an eye. A dozen examples have occurred from the Tay tide-pools. (Fig. 23.)

24. *Monura micromela.* Lorica in dorsal aspect broadly ovate, produced behind into slightly projecting points, separated by a shallow rounded sinus: in lateral aspect the quadrant of an oval: foot small; toe single, of uniform excessive tenuity. Length 1/230 in. Lacustrine.

I have had, for thirty-six years, drawings of a species which I had marked (with "?"), as *Monura dulcis.* Very recently, in water from Slough, what seems the same form, now figured, has occurred, and that repeatedly. The excessive tenuity of the toe, which seems indivisible, is the most striking feature; and then the round sinus between the lorica-points (*m*). No eye is visible. The general figure is that of *Col. bicuspidatus.* (Fig. 24.)

II.—*Fresh-water Algæ (including Chlorophyllaceous Protophyta) of North Cornwall; with descriptions of six new species.*

By Alfred W. Bennett, F.R.M.S., F.L.S., Lecturer on Botany at St. Thomas's Hospital.

(*Read* 12*th January*, 1887.)

Plates III. and IV.

So little is known accurately of the geographical distribution of any of our fresh-water algæ, that it seems to me a complete record may not be without value of all the species observed during a six weeks' stay in North Cornwall, in August and the early part of September 1886. The localities from which gatherings were made were entirely in the northern part of the county, from Boscastle to Newquay, a distance of about thirty miles, and mostly within a short distance of the sea. This is chiefly a limestone country, no granitic or other volcanic districts having been visited. It is characterized by the entire absence of peat-bogs over a large portion of the area; but the few examined, at Mawgan, Roche, and St. Denis, were rich in desmids and other organisms.

On comparing this list with that made in the previous year in the English Lake Country, they are seen to differ considerably.* It is not, however, in any way suggested that either list approaches completeness, or that the species which occur in one only of the lists may not ultimately be found in both districts. In order to facilitate the comparison I have prefixed an * in the present list to those species not included in that for the Lake District. Some general comparisons between the two may, however, be interesting.

EXPLANATION OF PLATES III. and IV.

Fig. 1.—Apiocystis Brauniana Näg. × 200.
„ 2.—Hydrianum heteromorphum Reinsch × 400.
„ 3.—Aphanothece microscopica Näg. × 100.
„ 4.—Oscillaria princeps Vauch. × 200.
„ 5.—Stigonema minutum Hass. ? (outline only) × 100.
„ 6, 7. „ „ portions of primary filament × 200.
„ 8. „ „ portion of primary filament, showing attachment of branch, × 200.
„ 9, 10 „ „ portions of branch, × 200.
„ 11.—Pediastrum integrum Näg., young cœnobium × 300.
„ 12. „ „ older cœnobium × 300.
„ 13. „ „ portion of ditto, showing possible resting-cell *a*, × 400.
„ 14.—Cœlastrum cubicum Näg. × 600.
„ 15.—Selenastrum bifidum Benn. × 400.
„ 16. „ „ „ single cell × 600.
„ 17.—Docidium granulatum Benn. × 400.
„ 18.—Euastrum oblongum Grev. *var.* integrum Benn. × 200.
„ 19.— „ crassum Bréb. *var.* cornubiense Benn. × 200.
„ 20.— „ crenulatum Benn., front view × 600.
„ 21. „ „ „ end view × 600.
„ 22.—Cosmarium sphericum Benn. × 300.
„ 23. „ discretum Benn. × 400.
„ 24.—Staurastrum cornubiense Benn. × 800.

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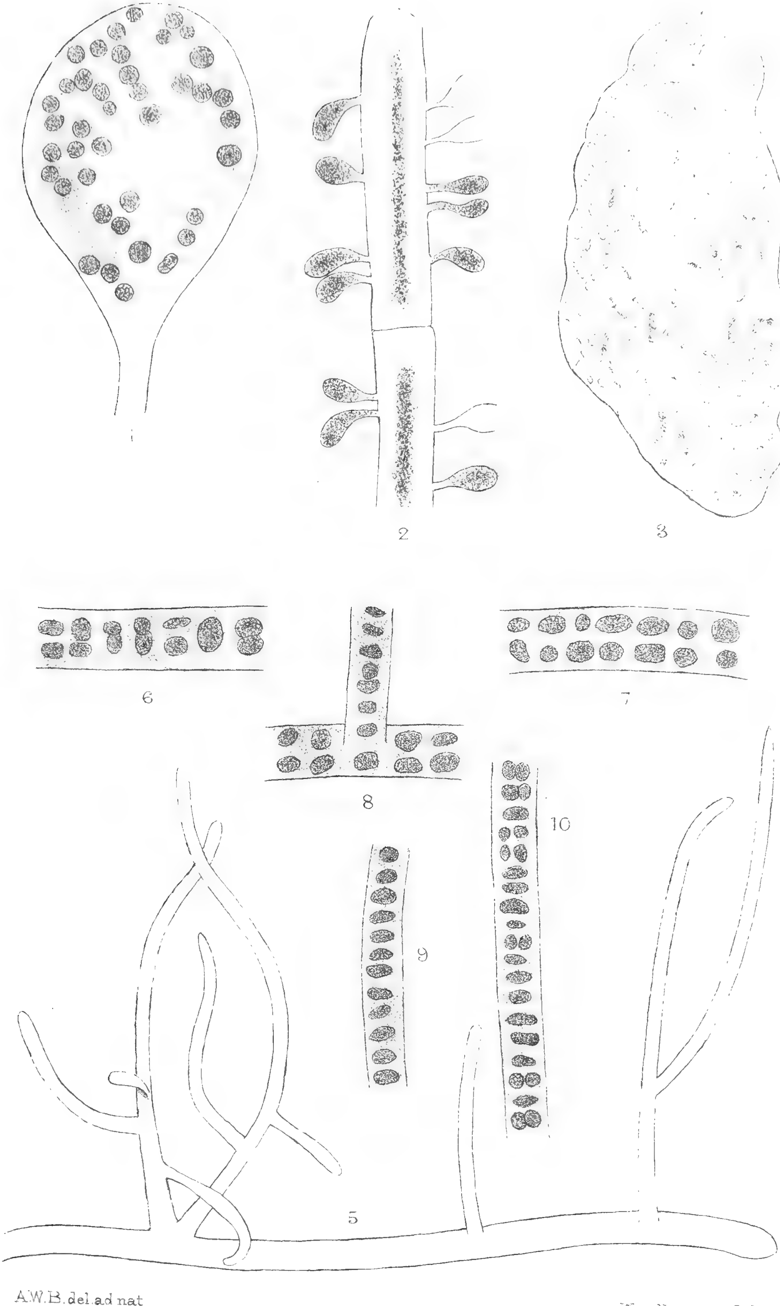
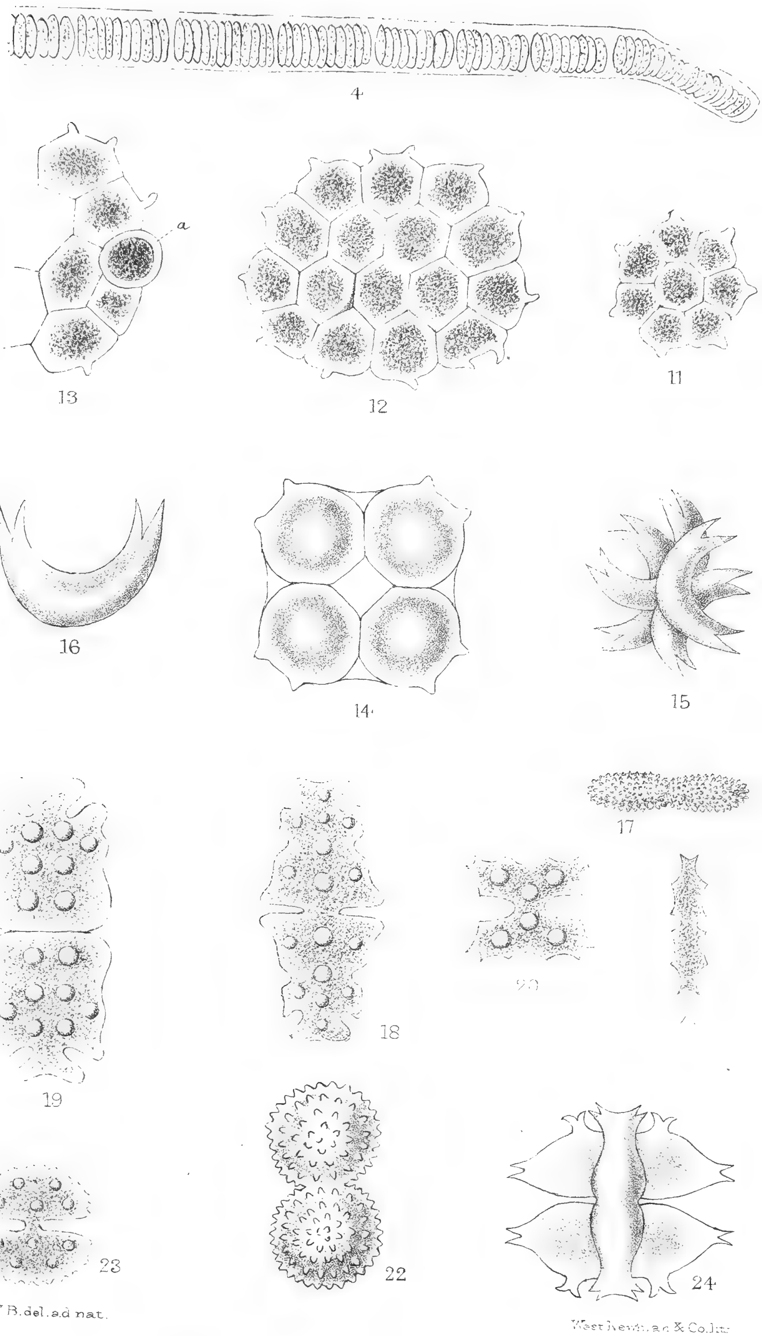
* This Journal, 1886, pp. 1–15.



A.W.B. del. ad nat.

West, Newman & Co. lith.

Algæ &c of North Cornwall.



A.W.B. del. ad nat.

West Newman & Co. lith.

Algæ &c. of North Cornwall

The occurrence of five out of the seven British fresh-water Ulvaceæ in the Cornwall list, all absent from that for Westmoreland, is probably due to the proximity of the sea. Of greater interest is the observation of several species of microscopic Protophyta which may be included in the family Characiaceæ, using the term in its larger sense. This, I have little doubt, is due to the lower latitude; and it is probable that further search, and a better acquaintance with this class, might lead to the discovery of a number of new and interesting forms. Among the beautiful Pediastreæ and Sorastreæ I have had the good fortune to meet with four very interesting species which have not hitherto been observed in Britain, one of them new to science, as also a very striking *Oscillaria.* The greater number of the Desmidieæ were gathered in pools on the few peat-bogs above referred to. Comparing them with my experience of the Lake District, I must note the comparative absence of the larger species, especially *Micrasterias, Xanthidium, Holocystis,* the larger *Euastra,* and the whole of the filamentous forms, though this applies more to the comparative paucity of individuals than to a reduction in the number of species. On the other hand, the larger *Cosmaria* and *Closteria* were quite as frequent, while the genera *Penium* and *Docidium* were more abundant, at least as far as the number of individuals is concerned. I was also struck with the large number of extremely minute forms belonging to the genera *Cosmarium, Staurastrum,* and *Arthrodesmus,* some of which, I cannot doubt, represented species hitherto undescribed.†

PROTOPHYTA.

Protococcaceæ (including Palmellaceæ).

Eremosphæra viridis dBy.
Glœocystis vesiculosa Näg.
* „ ampla Ktz.
Botryococcus Braunii Ktz.
Rhaphidium falcatum Cooke.
* „ aciculare Br. Bog pool, Mawgan.
Protococcus viridis Ag.
*Chlorococcum frustulosum Carm. Boscastle.
„ gigas Grün.
*Polyedrium tetrahedricum Näg. Bog pool, Mawgan.
Scenedesmus acutus Mey.
„ quadricauda Bréb.
* „ obtusus Mey.

Not unfrequent in bog pools. I do not find the character by any means constant that the cells are always "remote from one another"; their contact is frequently as close as in *S. acutus.*

Characiaceæ.

*Apiocystis Brauniana Näg. Fig. 1.

This interesting organism was seen only once, attached to *Zygnema insigne* in a mill-dam in the valley of the Gannel. It appears to have

† The names of new species are again printed in SMALL CAPITALS, those of species new to Britain in *italics.*

been detected in this country only once before, by Henfrey, as long ago as 1856, at Wimbledon. My observations agree nearly with the descriptions of Nägeli and Cooke, but I was not fortunate in having the mode of reproduction under view The "frond" was irregularly pear-shaped, with well-defined outline, 275 μ long by 165 μ broad (including stalk), the stalk 62·5 μ long by 25 μ broad. The "gonidia" or green pseudo-cells appeared to be arranged in a parietal layer, some of them in pairs as if they had undergone recent division, moderately crowded towards the apex of the "frond," fewer towards the base, entirely wanting in the stalk. They were bright green, round or slightly oval, about 17 μ in diameter or less.

*Dictyosphærium Ehrenbergianum Näg.

Bog pool, Mawgan. In the specimens observed the reniform pseudo-cells were united together in pairs or threes by a slender thread; the whole colony was moving rapidly through the water, but was not inclosed in hyaline gelatin.

In the same pool was observed what is probably an undescribed species of the same genus; the cells much smaller and spherical, and united together irregularly in bunches.

*Hydrianum heteromorphum Reinsch. Fig. 2.

Attached to a *Mesocarpus* in a bog pool, Mawgan. Cells about 19 μ long by 10 μ broad, observed both closed and open, filled with a light brown endochrome.

CHROOCOCCACEÆ.

Chroococcus turgidus Näg.
*Glœocapsa polydermatica Ktz. On wet rocks, Boscastle.
Aphanocapsa virescens Rabh.
Microcystis marginata Kirchn.
*Cœlosphærium Kützingianum Näg.

Very common in bog pools. The "frond" may be nearly spherical or 2–3-lobed, always studded with pale blue-green projections. When 2-lobed, and the lobes nearly equal in size, it might readily, but for its blueish-green colour, be mistaken for a *Cosmarium*.

Merismopedia glauca Näg.
**Aphanothece microscopica* Näg. (Gatt. Einzell. Algen, p. 59, t. i. H. f. 1). Fig. 3.

Not uncommon in bog pools. Thallus irregularly oval, outline lobed or sinuous, about 650 μ long by 325 μ broad, perfectly colourless and hyaline. "Gonidia" or pseudo-cells narrowly elliptical, 25–40 μ long, 4–5 times as long as broad, somewhat pointed at both ends and usually divided or constricted in the middle, sparingly and nearly uniformly scattered through the thallus. Contents of pseudo-cells very pale blue-green. Differs from both the species described by Cooke as British in the thallus being colourless instead of blue-green, as well as in other points. First described by Nägeli from Zurich; Rabenhorst speaks of it as abundant in Germany.

OSCILLARIACEÆ.

Oscillaria tenuis Ag.
* „ tenerrima Ktz. Bog pool, Roche.
* „ muscorum Carm. Bog pool, St. Denis.
**Oscillaria princeps* Vauch. Fig. 4.

Filaments free-swimming, quite solitary, 30–38 μ broad without the sheath, about 44 μ including the sheath, 20–40 times as long as broad. Invested in a very thin mucous sheath, fitting closely to the filament, and sometimes projecting slightly beyond it where broken. The filament is somewhat suddenly narrowed at both ends to a tapering extremity, which bends downwards; otherwise it is quite straight. Endochrome a very bright blue-green, obscurely divided into pseudo-cells about three times as broad as long, much narrower in the curved ends; it shows here and there indications of breaking up into the "cellulæ perdurantes" described as specially characteristic of the genus *Lyngbya.*

This fine species was seen several times in bog pools; the filaments always moving backwards and forwards with a slow horizontal motion. It might readily, at first sight, be mistaken for a *Desmidium,* which it resembles in form and size. The thin mucous sheath, and the tendency of the contents of the filament to break up into resting-cells, seem to indicate an affinity with *Lyngbya;* but the form of the extremities of the filaments is altogether that of an *Oscillaria.* I have some doubt in identifying it with Vaucher's species, which is described by Rabenhorst as forming a mucous stratum, while this was observed by me only in rare solitary filaments. On the whole, however, it seems to agree with this species, though it also shows considerable resemblance in size, and in its solitary filaments, to *O. percursa* Ktz. *O. imperator* Wood I take to be identical.

The genus *Oscillaria* is at present very poorly represented in the British flora. Dr. Cooke includes only twenty species in his 'British Fresh-water Algæ; while Rabenhorst, in his 'Flora Europæa Algarum,' enumerates no less than sixty-four, many of them, however, of only very doubtful value. The larger species in particular are conspicuously absent from our flora; and the addition of this, perhaps the most striking of all, is therefore of some interest.

Lyngbya ochracea Thur.
*Spirulina oscillarioides Turp. Bog pool, Roche.

SIROSIPHONEÆ.

*Stigonema minutum Hass.? Figs. 5–10.

Whether this species is correctly named I am very uncertain. Isolated fragments were observed several times, intermixed with other floating algæ, on a bog pool at Mawgan. The main filament averages about 40 μ in thickness; from this proceed branches on one side only, frequently in pairs, these again branching copiously; the average thickness of the branches is about 25 μ. There was no indication of a mucous sheath. The branches contain a single row of elliptical pseudo-cells, the broader axis at right angles to the direction of the filament;

but in places the pseudo-cells were arranged in two rows, and they were then smaller and nearly spherical. In the main filament there were mostly two rows of nearly spherical, interspersed with a few larger elliptical, pseudo-cells in a single row. The largest of these pseudo-cells were about 32·5 μ by 20 μ. The contents of the pseudo-cells were brown in the main filament, more often a light green in the branches; the entire filament externally to the pseudo-cells being also filled with a light brown endochrome.

Following Rabenhorst, Dr. Cooke regards *Stigonema* as a genus of lichens. Whether this view is correct or not I express no opinion; but the organism here figured, which agrees with the general description of the genus, unquestionably carries on an independent existence, like any other fresh-water alga or protophyte. As Cooke's figure appears to be taken from a dried specimen only, I have presented, by way of comparison, one from the living plant.

Nostocaceæ.

*Anabæna flos-aquæ Ktz. Frequent.
Cylindrospermum macrospermum Ktz.
Nostoc hyalinum Benn. (Journ. R. Micr. Soc., 1886, p. 4, t. i. f. 2, 3).

This pretty *Nostoc*, obtained last year in the Lake District, was again observed, but only once, in a bog pool at St. Denis. I am unable to accept Dr. Cooke's suggestion that it is identical with *N. minutissimum* Ktz., the mature "frond" differing from that species in size, in the degree of complexity of the trichome, and in other points.

ALGÆ.

Pediastreæ.

Pediastrum Boryanum Turp.
" Ehrenbergii Br.
* " rotula Br.
**Pediastrum* (*Anomopedium*) *integrum* Näg. Figs. 11–13.

This interesting *Pediastrum* represents a section of the genus not hitherto detected in Britain, distinguished by the peripheral cells being neither lobed nor incised. The cœnobium consists of 8–16–32 cells, and is nearly round or irregularly oval, when mature about 125 μ long by 100 μ broad, compact, without any intercellular lacunæ. The cells are very regular and thick-walled, about 25 μ in diameter, the central ones symmetrically hexagonal, the peripheral cells alternately obscurely hexagonal and obscurely pentagonal, with rounded outer margin, not differing in their endochrome from the central cells. In an early stage, when the cœnobium consists of eight cells, each peripheral cell has a single central short obtuse hyaline process; at later stages each peripheral cell has usually two such processes at the obscure angles, one pointing upwards, the other downwards; but one or both may be entirely wanting. On losing their hyaline processes the peripheral cells exhibit a tendency

to round themselves off, the endochrome becoming at the same time darker in colour (*a*, fig. 13), possibly the commencement of the formation of reproductive resting-cells.

My plant agrees very closely with Nägeli's description and figure (Gatt. Einzell. Algen, p. 96, t. v. B. f. 4). It was observed only on the wet sides of a well at Tintagel, where it appeared to be abundant. It is recorded from several places in Germany.

Sorastreæ.

*Cœlastrum sphericum Näg. Bog pools, frequent.

**Cœlastrum cubicum* Näg. Fig. 14.

Cœnobium free-swimming, about 45 μ in diameter, composed of eight cells arranged in a cube. The front view shows a rectangular space in the centre surrounded by four nearly spherical cells, very obscurely hexagonal in outline, 22·5 μ in diameter, with homogeneous bright green endochrome. Each cell has two blunt shallow hyaline processes at the outer corners, and there is also a shallow hyaline band in the sinus between each pair of cells.

I cannot find that this very pretty organism has been seen or described except by its discoverer (Nägeli, Gatt. Einzell. Algen, p. 97, t. v. C. f. 2), whose figure is evidently imperfect. Rabenhorst is certainly in error in identifying it with *C. sphericum*, from which it is abundantly distinct. In bog pools, Mawgan, apparently not uncommon.

*Selenastrum bifidum n. sp. Figs. 15 and 16.

Cœnobium free-swimming, nearly spherical in outline, about 60 μ in diameter, composed of 8–16 cells. Cells bright green, somewhat broadly lunate, all with their apices pointing outwards, narrowing towards each apex, which ends in two straight hyaline processes, from one-fifth to one-sixth the length of the cell, about 35 μ long (without the spines) by 15 μ broad.

The genus *Selenastrum*, distinguished by its lunate cells, has been hitherto represented in our flora only by the doubtful species *S. Bibrianum* Reinsch. The present species comes near to *S. gracile* Reinsch, but is distinguished by the cells being broader in proportion to their length, and bidentate at the apex instead of simply falcate. It was seen frequently in gatherings from bog pools, Mawgan.

**Sorastrum bidentatum* Reinsch. Bog pool, Mawgan.

Pandorineæ.

*Eudorina elegans Ehrb.

In a roadside ditch, Roche, among *Zygnema insigne*, very abundant; also in running water and in bog pools, Mawgan. In none of a large number of individuals under observation was a red "eye-spot" detected.

*Gonium pectorale Müll.

Roadside ditch, Roche, with the preceding. When observed it was always swimming with the "frond" placed vertically.

ULVACEÆ.

*Prasiola crispa Ktz. On damp ground, valley of the Gannel, frequent.

* „ furfuracea Menegh. On a water-wheel in the valley of the Gannel.

* „ calophylla Menegh. With the preceding.

*Enteromorpha intestinalis Lk.

Very abundant on moist ground, valley of the Gannel, only slightly above high-water mark.

*Monostroma Wittrockii Born.

Along with *Prasiola furfuracea* and *calophylla.* Dr. Cooke hesitates on placing this species among fresh-water algæ; it is certainly, according to my observation, entitled to a position there.

ULOTRICHACEÆ.

Hormiscia moniliformis Rabh.

„ cateniformis Ktz.

Ulothrix zonata Ktz.

CONFERVACEÆ.

*Cladophora flavescens Ag.

Conferva fontinalis Berk.

„ bombycina Ag.

Microspora vulgaris Rabh.

„ floccosa Thur. Very commonly more or less of a brown tint.

*Chætomorpha Linum Ktz.

Fresh-water stream, Mawgan, along with several species of *Spirogyra.* Cells varying greatly in colour in the same filament.

* „ implexa Ktz. With the preceding.

*Rhizoclonium Casparyi Harv. With the two preceding species.

DIATOMACEÆ.

*Epithemia turgida W. Sm.

Eunotia Arcus W. Sm.

Cymbella affinis Ktz.

Surirella biseriata Bréb.

„ linearis W. Sm.

„ pinnata W. Sm.

* „ splendida Ktz.

* „ constricta W. Sm.

Nitzschia sigmoidea W. Sm.

„ linearis W. Sm.

„ Amphioxys W. Sm.

*Amphora ovalis Ktz.

Navicula rhomboides Ehrb.

„ rhyncocephala Ktz.

„ ovalis W. Sm.

Pinnularia major W. Sm.
„ viridis W. Sm.
„ oblonga W. Sm.
„ radiosa W. Sm.
„ gracilis Ehrb.
Stauroneis Phœnicentron Ehrb.
„ gracilis Ehrb.
Synedra radians W. Sm.
„ Ulna Ehrb.
„ fasciculata Ktz.
* „ capitata Ehrb.
Gomphonema constrictum Ehrb.
„ acuminatum Ehrb.
Himantidium pectinale Ktz.
*Odontidium mutabile W. Sm.
Fragilaria capucina Desm.
Diatoma vulgare Bory.
„ elongatum Ag.
Tabellaria flocculosa Ktz.

Desmidieæ.

Hyalotheca dissiliens Sm. Comparatively very scarce.
* „ mucosa Ehrb.
Didymoprium Borreri Ralfs.
* „ Grevillei Ktz. Bog pools, Mawgan.
Sphærozosma vertebratum Bréb.
Docidium nodulosum Bréb.
„ truncatum Bréb.
„ clavatum Ktz. Very common in bog pools.
* „ Ehrenbergii Ralfs. Bog pools, Mawgan.
„ baculum Bréb.
*Docidium granulatum n. sp. Fig. 17.

Frond minute, about five times as long as broad, 50 μ by 10 μ, slightly constricted in the middle, conspicuously covered with pearly granules. Endochrome dark green, with a lighter transverse band in the centre.

Bog pool, Mawgan, occasional. About the size of *D. minutum* Ralfs. Nearest to *D. asperum* Ralfs, from which it differs in its dimensions, in the central constriction, and in the ends not being dilated.

Cylindrocystis diplospora Lund. Frequent in bog pools.
Penium margaritaceum Ehrb.
„ cylindrus Ehrb.
„ digitus Ehrb. Much the most common desmid, and remarkably variable in size.
„ interruptum Bréb.
„ Brebissonii Ralfs.
Tetmemorus Brebissonii Menegh.
„ granulatus Bréb.
„ penioides Benn. (Journ. R. Micr. Soc., 1886, p. 13, t. ii. f. 26). Bog pool, Mawgan.

Spirotænia condensata Bréb.
,, obscura Ralfs.
Closterium lunula Ehrb.
,, turgidum Ehrb.
,, acerosum Schrank.
,, Ehrenbergii Menegh.
,, Dianæ Ehrb.
,, didymotocum Corda var. β Ralfs.
,, costatum Corda.
,, striolatum Ehrb.
,, juncidum Ralfs.
,, acutum Bréb.
* ,, setaceum Ehrb. Bog pools, Roche and St. Denis, occasional.
Micrasterias denticulata Bréb.
,, rotata Grev.
,, crenata Bréb.
Euastrum verrucosum Ehrb.
,, oblongum Grev.
* ,, oblongum var. INTEGRUM n. var. Fig. 18.

Frond about the size of the normal form, oblong in outline. Each frustule rather longer than broad, broadest at the base, 5-lobed; basal lobes nearly half the length of the frustule, concave; lateral lobes also concave; terminal lobe quite entire. Along the centre of each frustule is a row of conspicuous protuberances; and there are two other lateral protuberances in each frustule.

Peat bog, Mawgan. This form appears to be intermediate between *E. oblongum* Grev. and *E. multilobatum* Wood. It differs from the typical *E. oblongum* in little but the entire absence of the notch in the terminal lobe, which hardly seems sufficient for the establishment of a new species. Wolle (Desmids of the United States) also mentions the occasional absence of the notch.

Euastrum crassum Bréb.
* ,, crassum var. CORNUBIENSE n. var. Fig. 19.

Frond about the size of the normal form, 140 μ long by 105 μ broad at its greatest width. Outline of frustule without the terminal lobe nearly rectangular; sides nearly parallel; lower half somewhat convex, then a rounded projection, and terminating in a prominent cuneate shoulder. Terminal lobe emarginate, but not deeply notched. Two rows of large protuberances in each frustule, and in addition a protuberance in the lateral projections.

Bog pool, St. Denis. Closely resembles the very abundant *E. crassum*, with the exception of the projection below the shoulder.

Euastrum Didelta Turp.
,, ansatum Ehrb.
,, circulare Hass. var. *a* Ralfs.
,, pectinatum Bréb. Very abundant.
,, elegans Bréb. β inerme Ralfs.

Euastrum erosum Lund.
„ insulare Wittr.
„ binale Bréb.
*Euastrum crenulatum n. sp. Figs. 20 and 21.

Frond very minute. Each frustule 25 μ long by 11 μ deep, broadest at apex; with two teeth at each outer angle and one at the base; sides concave; apical edge with three concave crenations, of which the centre one is the largest. Isthmus 7 μ wide and deep, with a broad sinus on each side. Each frustule with three prominent protuberances.

Bog pools, not uncommon. This pretty desmid does not seem to come very near to any other species with which I am acquainted. The appearance presented by the end view indicates its right place in *Euastrum*. The front view strikingly resembles *Staurastrum Renardii* Reinsch; but the end view is totally different. *Cosmarium Regnesii* Reinsch is also somewhat similar in outline.

Cosmarium cucumis Corda.
„ pyramidatum Bréb.
„ crenatum Ralfs.
„ undulatum Corda.
„ tetraophthalmum Ktz.
„ botrytis Bory.
„ margaritiferum Turp.
„ Brébissonii Menegh.
„ speciosum Lund.
*Cosmarium sphericum n. sp. Fig. 22.

Frond moderately large. Frustules very nearly spherical, about 45 μ long and broad, covered with very prominent projections, which give them a very deeply crenulated edge; sinus rather deep. Endochrome very dark green.

The frustules of this very beautiful desmid are more nearly spherical than those of any other species of nearly the same size. It is further distinguished by the very conspicuous papillæ which cover the whole surface, resembling those of *C. cristatum* Ralfs, and by the deep green of the abundant endochrome. It comes near to *C. Brebissonii* Menegh., but the frustules are more nearly spherical, and to *C. Logiense* Biss. (Journ. R. Micr. Soc., 1884, p. 194, t. v. f. 4), but the description of the latter is hardly full enough for identification; *C. orbiculatum* Ralfs is considerably smaller. I found it not unfrequently in gatherings from bog pools.

Cosmarium cœlatum Ralfs. Common.
„ ornatum Ralfs.
„ cristatum Ralfs.
„ cucurbita Bréb.
* „ Broomei Thw. Bog pool, St. Denis.
*Cosmarium discretum n. sp. Fig. 23.

Frond small. Frustules nearly semi-elliptical or slightly reniform, 37·5 μ by 17·5 μ, rough with pearly granules. Isthmus very con-

spicuous, separating the two frustules widely from one another, 11 μ long by 6 μ wide, quite colourless. Cell-membrane punctate, and with five distinct protuberances in each frustule.

Bog pools, Roche and St. Denis. Nearest to *C. excavatum* Nordst., but larger; *C. Portianum* Arch. belongs also to the same section.

*Cosmarium bioculatum Bréb. Bog pools, not unfrequent.
,, moniliforme Turp.
* ,, Meneghinii Bréb. Bog pools, Roche and St. Denis.
,, Wittrockii Lund.
Xanthidium aculeatum Ehrb.
,, fasciculatum Ehrb.
* ,, cristatum Ehrb. var. *a* Ralfs. Frequent.

This species is well distinguished by the solitary basal spine, which is, however, frequently rudimentary or altogether wanting.

Staurastrum dejectum Bréb.
,, Dickiei Ralfs.
,, muticum Bréb.
,, teliferum Ralfs.
,, Pringsheimii Reinsch.
,, alternans Bréb.

*Staurastrum (Didymocladon) cornubiense n. sp. Fig. 24.

Frond minute, 35 μ long, 28 μ broad. Each frustule elliptical, but with the lower edge flatter than the upper rounded edge, 2–3-dentate at the base, and with a bifurcate colourless process on the shoulder. In front of each frustule is a large ovate protuberance, much deeper green than the rest of the frond, ending in two bifurcate horns, 14 μ long including the horns, 7·5 μ broad.

Bog pool, Roche, occasional. Belongs to the section (Ralfs's genus *Didymocladon*) in which each frustule is furnished with bifurcate processes. It is considerably smaller than most of the section, resembling most nearly, in this and other respects, *S. pseudofurcigerum* Reinsch, but the very remarkable urn-shaped protuberance well distinguishes it from all other forms yet described.

Staurastrum polymorphum Bréb.
,, gracile Ralfs.
* ,, cyrtocerum Bréb. Bog pool, Mawgan.
* ,, paradoxum Mey. Bog pools.
* ,, tetracerum Ktz. Bog pools.
Arthrodesmus Incus Bréb.
,, convergens Ehrb.

Zygnemaceæ.

Spirogyra porticalis Vauch.
,, longata Vauch.
* ,, nitida Dillw. Mill-dam, valley of the Gannel, and elsewhere, frequent.
*Zygnema insigne Hass. With the preceding.
,, Hassallii Benn.? (*Z. anomalum* Cooke). Not seen in conjugation.

MESOCARPEÆ.

Mesocarpus scalaris dBy.? Not seen in conjugation.
*Staurospermum capucinum Ktz. Bog pools, Mawgan.

SIPHONEÆ.

Vaucheria sessilis Vauch. Frequent.

ŒDOGONIACEÆ.

Bulbochæte pygmæa Wittr.
Bog pools and running water, occasional.

BATRACHOSPERMEÆ.

*Chantransia pygmæa Ktz.
In running water, Mawgan, along with a *Vaucheria* sp. indeterm., and several Zygnemaceæ and Confervaceæ.

P.S.—Since writing the above, I have seen Reinsch's paper on Lagerheim's genus *Acanthococcus* in the 'Berichte der deutschen botanischen Gesellschaft,' and recognize one or more of his species as having been frequently seen by me in gatherings both in Westmoreland and Cornwall, but have not preserved exact descriptions or drawings. No species of the genus has as yet been recorded from the British Islands. Reinsch's surmise is probably correct, that they have been taken for zygospores of desmids. They should be looked for by other observers.

III.—*On Improvements of the Microscope with the aid of New Kinds of Optical Glass.**

By Prof. E. Abbe, Hon. F.R.M.S.

(*Read* 13*th October*, 1886.)

Since the year 1881, Dr. Schott, of Jena, and the author, with active co-operation from the optical workshops of Zeiss, have undertaken a prolonged investigation into the improvement of optical glass, the result of which has been the production of new kinds of glass for the use of opticians.

By spectrometric observation of numerous experimental fusions, systematically carried out with a great variety of chemical elements, the relation between the optical properties of the amorphous (glassy) products and their chemical composition has been more closely investigated; and on the basis of the results so obtained suitable syntheses have been made by which it has been possible to produce glass having desired optical properties.

In this way, by the use of many more chemical elements than have hitherto been employed in the manufacture of glass, especially by the use of phosphoric and boric acid as essential constituents of glass fluxes, where formerly silica was alone used, two hitherto unattainable requirements of practical optics have been satisfied. In the first place, crown and flint glass can be produced in which the dispersion in the different parts of the spectrum is nearly proportional, so that in achromatic combinations it is now possible entirely, or almost entirely, to do away with the hitherto unavoidable secondary spectrum; secondly, the kinds of glass which can be used for optical purposes have been so increased in variety that, while the mean index of refraction is constant, considerable variations can be given to the dispersion, or to the refractive index while the dispersion remains constant; in particular, a high index of refraction is no longer necessarily accompanied by a high dispersion (in flint glass), but may be retained (in crown glass) with a low degree of dispersion.

The regular supply of optical glass in answer to such increased demands seems to be insured for the future, since as a direct result of the above-mentioned experiments, and with the co-operation of the Royal Prussian Education Office, a glass factory has been established at this place (the Glastechnisches Laboratorium of Jena), which has meanwhile commenced the manufacture of all kinds of optical glass for general use.

The circular which has recently been issued by this institution gives preliminary information of a more detailed character to those who are interested in the subject, prior to the appearance of a complete description of the results of the experiments.

The new materials which are thus placed at the disposal of practical optics by an extension of glass manufacture from a scientific point

* The original paper is written in German (translated by Mr. H. A. Miers of the British Museum, Natural History, and revised by the author). Cf. SB. Jen. Gesell. f. Med. u. Naturw., 9th July, 1886, 24 pp.

of view, introduce considerable changes in the fundamental treatment of dioptrical problems, and are calculated to open up in different directions paths for the development of optical instruments which have hitherto remained closed.

As regards the Microscope, an endeavour has been made to obtain improvements with the help of these materials through the workshops of Zeiss, the author having undertaken the necessary theoretical investigation. The following is a notice of the aims at which this research was directed, and the results to which it has led.

Objectives.

By judicious use of the new glass-fluxes, and particularly those which have been produced by the aid of phosphoric and boric acid, together with silicate glass of different compositions, it is possible to remove two important defects in regard to objectives, which have hitherto placed insuperable obstacles in the way of the further perfecting of the Microscope, since they could not be overcome with the means hitherto available.

Complete achromatism has always been unattainable on account of the great disproportionality of the dispersion at different parts of the spectrum, which is peculiar to the ordinary crown and flint glass. In the best objectives it has not been possible really to unite more than two different colours of the spectrum; the inevitable deviation of the rest—the so-called secondary spectrum—always left coloured circles of dispersion of appreciable extent and intensity. Besides this, it has been impossible with the glass hitherto available, at least with types of construction which could be used in practice, to correct the *spherical* aberration for more than *one* colour. With all objectives, when the spherical aberration has been removed as far as possible for the centre of the spectrum, there has remained a spherical under-correction for the red, and an over-correction for the blue and violet rays, and this defect has made itself felt in practice as a more or less marked inequality between the *chromatic* corrections for the central and the peripheral zones of the objective.

Both these defects unite in making the concentration of the rays in the image formed by the objective less complete in proportion as the aperture of the objective increases; therefore, in objectives of considerable aperture, the available magnifying power is reduced to such as can be obtained with relatively low eye-pieces, because with higher eye-piece magnification the imperfections of correction become inconveniently visible, and necessitate the employment of objectives of very short focal length, if a high magnifying power with an image of satisfactory definition (therefore with a low eye-piece) is to be obtained.

Both these imperfections in the convergence of the rays in the achromatic objectives hitherto used can now be as good as entirely eliminated by the use of the new glasses.

In the first place the secondary chromatic deviation is removed and reduced to a practically harmless residue of colour of a *tertiary* character, and this has not been hitherto even approximately effected in any kind of optical construction. Secondly, the chromatic difference of

the spherical aberration can be eliminated, that is to say, the spherical aberration can be completely corrected for *two different* colours of the spectrum at once (and therefore practically so for all colours).

The latter object has hitherto been attained in certain kinds only of telescope objectives, for which it was originally formulated by Gauss, without however—for want of a simultaneous correction of the secondary dispersion—any decided advantage being gained.

The fulfilment of the first condition depends upon the employment of pairs of glasses in which the so-called relative dispersion, the quotient $\frac{\Delta n}{n - 1}$, differs considerably, while the ratio between the partial dispersions at different parts of the spectrum is at least approximately constant, or in which on the other hand the quotient is constant while the latter ratio is different. Now this is entirely a matter of the chemical composition of the glass; the experimental researches mentioned at the outset, have established the fact that in the series of silica glasses this requirement cannot be satisfied, but it is so when phosphates and borates are used in combination, the former as a substitute for crown, the latter for flint glass. The circular of the Glastechnisches Laboratorium gives the results of the spectrometric measurements of a number of such glasses, and thus supplies the requisite data for their application to the purpose in question by means of the usual methods of calculating the colour dispersion in optical systems.

The second requirement, which refers to spherical aberration, involves in the case of systems of so great an aperture as are used with the Microscope, the consideration of very complicated relations between the separate elements of the system which have not yet been expressed in a general form in the theory of dioptrics. So far as the author can at present see, the correction of these aberration differences depends upon a very *pronounced* accumulation of spherical deviations in one part of the system, which are compensated for by equal and opposite deviations in another part. If these purposely produced accumulations are to be correctly compensated, the possibility of varying the index of refraction independently of the dispersion, as may be done with the new glasses, will be an indispensable aid.

It was made clear from the theoretical consideration of the conditions of delineation, and it was practically proved by the objectives which have since been produced, that by the *simultaneous* fulfilment of both these requirements the *concentration of the rays* in the images formed by these objectives is essentially more perfect. Apart from the unusual purity of colour in the images, which is almost as perfect with oblique as with central illumination, the better or more complete concentration of the rays is evinced by the fact that the images may be further magnified by very high eye-pieces without appearing indistinct, and without producing the impression of insufficient light, provided only that the mechanical construction has been improved proportionately with the optical action.

As has been said above, the condition by which these properties are obtained in the new objectives, and the characteristic which distinguishes them from the dioptrical point of view, depends upon the elimination of

those errors which, while they have to a certain extent the character of spherical aberration, originate mainly in the unequal behaviour of differently *coloured* rays; in fact the elimination of these errors realizes an *achromatism of higher order* than has hitherto been attained. The objectives of this system may be therefore distinguished from achromatic lenses in the old sense of the word, by the term *apochromatism*, and may be called *apochromatic objectives.*

The practical advantages gained by these improvements are as follows:—

Firstly, the aperture of the objective can now be utilized to its full extent. In the case of the old objectives of somewhat considerable aperture, the inevitable defect in the convergence of the rays has to a great extent prevented a proper combined action of the outermost zone and the central parts of the aperture; for this reason it has never been possible to realize such a degree of resolving power as is to be expected by theory from a given aperture. In practice, therefore, these objectives perform like ordinary objectives of perceptibly *greater aperture.* For example, a dry objective of aperture scarcely greater than that of the higher dry systems at present used, gives with central illumination an image of *Pleurosigma angulatum*, which for clearness and distinctness of definition can scarcely be distinguished from the image obtained with good water-immersion lenses of the existing type. The water-immersion objectives are in the same way shown by corresponding observations to have an optical efficiency at least equal to that of the old homogeneous-immersions, if we do not take account of the practical advantage of the latter in dispensing with the cover-glass correction. The advantage is conspicuous with illumination by a *broad* central cone of light such as is given by a wide diaphragm.

In the second place, since with the new objectives there are no longer the same obstacles to a considerable increase of magnifying power *by the eye-piece*, the greatest magnifying power which can be utilized with a given aperture may now be obtained with an objective of relatively greater focal length, and very short focal lengths are rendered unnecessary.

Former investigations made by the author * have shown that with the best objectives of the old kind and with large apertures, the limits of a completely satisfactory clearness of image, such as is required in difficult observations, are reached when the *super*-amplification is 4–6 fold; that is to say, when the total magnifying power of the objective and eye-piece together is 4 to 6 times as great as that obtained with the objective when used by itself as a magnifying lens. Under these circumstances, to obtain a magnifying power of 1200—e. g. with an objective for homogeneous immersion—under satisfactory conditions, it is necessary to use an objective which has by itself a magnifying power of 200, and consequently a focal length of only $\frac{250}{200} = 1 \cdot 25$ mm. On the other hand, a number of careful comparisons have shown that with the apochromatic objectives the available super-amplification, even with

* "On the relation of Aperture and Power," see this Journal, 1883, p. 803.

the greatest apertures, is at least 12–15, and considerably higher with the medium and low objectives. A total magnifying power of 1200 requires therefore no more than an objective amplification of 80–100, and consequently it can now, with the help of higher eye-pieces,* be obtained with an objective of 3 to 2·5 mm. focal length, whereas it was formerly only possible with a focal length of 1·25 mm.

Even if but little value is attached to the removal of the inconvenience which unavoidably accompanies the use of objectives of very short focal length, there is *one* essential advantage gained at any rate: the limits within which each objective may be used are very materially extended, for a series of very different amplifications may be obtained by merely changing the eye-piece. It is clear that an objective of 3 mm. focal length, which by means of an eye-piece of suitable strength secures a magnifying power with good definition of 1200–1500, is in this respect of *greater* value than an objective of the much shorter focal length which has hitherto been necessary, because the former includes in itself the performance of a medium objective when a low eye-piece is employed.

Thirdly and lastly, the realization of an achromatism of higher order in microscopic objectives is of particular value in relation to photomicrography, because the correction errors of the ordinary achromatic systems exercise a disturbing influence in this case to a much greater extent than in observation with an eye-piece. As a result of these there is not only a considerable difference of focus between the optically and chemically active rays, which renders the correct adjustment for the photographic focus very doubtful, but in addition, since the spherical correction of the objective can only be effected with certainty for the brighter visible light, there always remains a marked spherical over-correction for the chemical rays which lie near the violet end of the spectrum, and on account of this the concentration of rays cannot be made so complete in the photographic image as with eye-piece observation. Both these defects are remedied in the apochromatic objectives, the former by the removal of the secondary colour-deviation, the latter by the production of a uniform spherical correction for *all* colours. Those objectives will therefore insure that the best chemical image shall lie in the same plane with the best optical image, and that the action of the former shall be as perfect

* With regard to the very general idea that the use of strong eye-pieces is *in itself* disadvantageous—that they involve loss of light, and that it is therefore essentially necessary for high magnifying powers to employ objectives of short focal length and low eye-pieces—it may be remarked that this view can neither be optically justified, nor does it correspond to a rightly interpreted experience, but has arisen in an unwarranted generalization from certain observations. "Dark" images are given by high eye-pieces if their use gives a *too great* (empty) magnifying power, i. e. if the total magnifying power rises above that value for which the details of the image, as determined by the aperture of the objective, are exhausted for the eye; and also if the concentration of the rays by the objective is so incomplete that it does not admit of the full magnifying power without at the same time making the defects visible. If neither of these conditions holds, the subjective impression of brightness is not affected, whether the magnifying power is obtained by the use of a strong objective with a low eye-piece, or by a weaker objective *of the same aperture* and a high eye-piece. The physical brightness of the image in every case depends only upon the aperture and the total magnifying power, and it is of no account in what way the latter is produced by means of focal length of the objective, length of tube, and focal length of eye-piece.

in regard to definition as the impression which is produced upon the retina by the latter.

According to theory, the photographic depiction of the microscopic image ought to have a not inconsiderable advantage as compared with eye-piece observation, on account of the essentially shorter wave-length of the light which is employed in the former case; with photography the objective produces an effect equal to an increase of aperture in the ratio of about 4 : 3 as compared with eye-piece observation. If, hitherto, as it appears, such an advantage has not been apparent in practice, the cause must be, in accordance with what has been said above, that the images formed by the chemical rays have never been so perfect, as regards concentration, as the visible images, and that this defect has counterbalanced the advantage of shorter wave-length. Experiments which have since been made with some of the objectives, constructed on the new principles, give ground for the expectation that in future the theoretical superiority of the photographic method will be realized.

The above-mentioned aims for the improvement of objectives, as well as indications of the way in which they are to be practically secured, were stated by the author some years ago.* He has also described experimental objectives which, with the use of strongly refracting liquids in the form of inclosure-lenses were made as early as 1873 in Zeiss's workshops,† with the object of practically testing his views, and, in the words which he then used, of getting "a glance at the Microscope of the future." So far therefore the present objectives are only the final elaboration of a plan for the improvement of the Microscope which has been pursued in these workshops for many years, but which remained so long in suspense because the glass manufacture could not supply the requisite material.

The elaboration of this plan has moreover led to a further advantage which, though of secondary importance, yet appears to be a desirable improvement. In all objectives of large aperture, in which the front-lens cannot be made achromatic by itself, there remains, even when the colour deviation along the axis (i. e. in the centre of the field) has been corrected as completely as possible, a not inconsiderable difference in the *magnifying power* for different colours (difference of the focal *length* of the objective for different colours when the position of the anterior focal *point* is the same), and this gives rise to marked colour deviation *outside* the centre of the field which makes itself apparent in conspicuous borders of colours at the margin. (The image formed by the blue and violet rays is *larger* than that of the red and yellow, it coincides with the latter at the centre of the field but extends over it more and more towards the margin.)

This defect of amplification cannot be corrected even in the apochromatic objectives except by very inconvenient methods of construction; but whereas the ordinary achromatic objectives are further complicated

* 'Bericht über die wiss. Apparate auf der Londoner Internationalen Ausstellung i. J. 1876' (Hofmann) 1878, pp. 415–20. See this Journal, 1884, p. 291.

† 'On new methods for improving Spherical Correction, &c.,' see this Journal, 1879, pp. 815–7.

by the fact that the amount of this difference in the colour amplification is very unequal in the central and peripheral parts of the *objective-opening,* in the apochromatic objectives it is approximately constant for all parts of the opening, and consequently allows of *correction by means of the eye-piece.*

For this purpose it is only necessary to construct the eye-piece in such a way that it may have an equal but opposite difference of magnifying power (or focal length) for different colours, that is, to use eye-pieces which are to a definite extent *un*achromatic. To effect this object it is necessary, if the eye-pieces are to be used with different objectives—as must of course be the case—that this difference of magnifying power for different colours should be made approximately the same in all objectives. This renders it necessary that objectives of small aperture (in which the difference of amplification can be easily avoided and which are usually found free from any such defect) must be *purposely* made defective in this respect to exactly the same extent as is the case in the objectives of large aperture in which it is unavoidable.

The result of this innovation is that now even objectives of relatively large aperture will give images very free from colour over the whole field, while their construction need not be more complicated for that purpose.

As regards the production of a *series* of objectives corrected in the above-described manner and satisfying the different practical requirements, the same considerations hold good which were formerly developed by the author with reference to the conditions of construction then existing. The altered conditions, as regards the degree of concentration of the rays attainable, can be expressed by modifying the numbers there given.

As the starting-point for each construction, the numerical aperture must be taken which finds its expression in the ratio of the free opening of the objective to its focal length. The superior limit of this element is in every class of objectives—dry, water-immersion, or homogeneous-immersion—almost invariably determined by the theoretical maximum; within this limit the determination of a particular value for a definite purpose remains a matter of free choice. When once the aperture is fixed it determines the type of combination of the lens system in general, and thence also the choice of the separate elements by which the requirements of the different conditions of correction are to be satisfied; the only point which remains open is the focal length with which the aperture in question is to be associated, that is the scale of construction, or the absolute dimensions of the system.

The choice of the focal length or the scale for a rational construction is based on the following considerations:—With the aperture are determined, on the basis of well-known and generally accepted laws, the linear measure of the smallest detail of the object which can be delineated by means of this aperture; the measure may be very approximately expressed numerically for every aperture.

It is then necessary that the smallest detail which can be reproduced in the image should be presented to the eye under a visual angle which is large enough for its clear perception, and the determination of this is

derived from known experiments. From these two data—the absolute size of the smallest reproducible detail in the object and the requisite visual angle of the same detail in the image—may be deduced the minimum value of the magnifying power which a Microscope with the given aperture *must* have if this aperture is to be fully utilized. On the other hand, it must be remembered that an increase of the visual angle beyond a certain small multiple of the value necessary for clear vision leads to an *empty* magnifying power which has no advantage for any purpose, and this multiple gives the maximum value which the total magnifying power of the Microscope does *not need* to exceed with the given aperture. In this way are obtained the limits of the *useful* magnifying power of an objective of given aperture.

The focal length which must be given to the objective *in order that by means of the eye-piece the magnifying power of the Microscope may be conveniently varied within these limits,* will depend entirely upon what proportion of the total magnifying power of the Microscope is to be obtained by the eye-piece.

On optical grounds there would here be no limitation if an absolutely perfect collection of the rays could be secured in the image formed by the objective. The division of the whole magnifying power between objective and eye-piece, would in this case be entirely immaterial as regards the optical effect. A limitation is however necessitated by the unavoidably imperfect collection of the rays, a result partly of uncorrected residual aberration in the objective, and partly of defects in its mechanical construction which cannot be completely overcome by any art. From both these causes the image produced by the objective exhibits not sharp points but circles of dispersion of greater or less diameter, which, with increased magnifying power in the eye-piece are presented to the eye under an increased visual angle, so that the sharpness and distinctness of the image is more and more affected. Having regard to these circumstances, the question then arises: how far can the requisite useful magnifying power be produced by the action of the eye-piece without making the circles of dispersion visible in the image?

The circles of dispersion which result from insufficient collection of the rays are in their absolute magnitude, when reduced to the measure of the object, directly proportional to the focal length of the objective, provided objectives of the same type and the same technical perfection are compared. From this it follows that the visual angle which they subtend at the eye *with a definite total magnifying power of the Microscope,* the objectives being otherwise similar, must be inversely proportional to the ratio of the focal length of the whole Microscope with this magnifying power to that of the objective, or directly proportional to the ratio of the total magnifying power N to the magnifying power n of the objective used by itself without eye-piece. This ratio $\frac{N}{n}$ which represents the increase of the magnifying power due to the eye-piece, consequently determines in the case of objectives of equal perfection the point at which the circles of confusion are visible, that is to say, for each degree of perfection there exists a definite value of this ratio beyond which defects in the union of the rays in the image pass the limits of distinct vision.

When this critical value of the super-amplification has been determined for any class of objectives, it fixes the focal length which must be given to an objective in order that the previously determined useful magnifying power corresponding to the aperture may be realised under satisfactory conditions, that is, so that the defects of the image do not make themselves felt. The admissible value of the eye-piece magnification (as defined above) may be represented by a number ν, while the total magnifying power which will be required for complete use of the aperture may be indicated by N; the *proper* magnifying power n of the objective should then be $\frac{N}{\nu}$, and the focal length therefore $250 \frac{\nu}{N}$ (mm.), when the numbers representing the magnifying powers are referred to the usual distance of vision of 250 mm. The estimation of the eye-piece magnification ν which is admissible with objectives of a given type, is therefore the factor which leads to a rational accommodation of focal length to aperture.

The determination of this figure is essentially a matter of experiment and practice, since it is not of general application, but can only be given with reference to a definite type of correction and a definite degree of mechanical perfection in the objective. Every advance in the direction of a more complete removal of spherical and chromatic aberration must naturally diminish the circles of dispersion in the objective image, and make itself perceptible through a higher value of the admissible eye-piece magnifying power, provided that at the same time the perfection of the workmanship satisfies the correspondingly increased requirements for the correction of errors of form and centering in the lenses.

As has been mentioned, objectives made of the new kinds of glass, corrected in accordance with the above-established conditions, and constructed with all possible skill, admit, as the author's observations show, of an eye-piece magnification (super-magnification) of at least 12–15, even with the greatest possible aperture, without rendering defects in the collection of the rays visible in the image. With the smaller apertures, such as are employed with the weaker dry systems, the admissible eye-piece magnification reaches much higher figures still. Consequently, in accordance with the rule given above, the highest *useful* magnifying power to be obtained by homogeneous immersion can be secured with an objective magnifying power of 80–100, and therefore with a focal length of about 3 mm., without loss in the perfection of the image. With the largest aperture of water-immersions, the focal length is about the same, and with the greatest aperture of a dry system about 4 mm.

That in future with objectives of this kind of correction focal lengths substantially less than 3 mm. will be in general superfluous, will be recognized, from what was said in the beginning, as a practical gain; and there appears, therefore, no reason why this consequence should not be practically realized. With dry systems, however, of considerably smaller apertures than 0·9, this theoretical determination of the focal length leads in some cases to such high values, that its practical application is inadvisable, since, especially with Microscopes of the Continental

type, it would be necessary to use eye-pieces of inconveniently short focal length to secure the necessary magnifying power. In the case of these weaker objectives, therefore, those of *shorter* focal length should be retained than are in themselves required for a given aperture.

A set of apochromatic objectives is constructed in the workshops of Zeiss in accordance with the principles here explained. In this series the apertures rise from 0·3 to 1·4; in each class—dry, water-immersion, and homogeneous-immersion—the theoretical maximum of aperture is realized to within 7 per cent. or less.

How far these innovations will prove of advantage in the scientific use of the Microscope can only be determined by long practice. As regards the point which is of the first importance for the extension of microscopic perception, the aperture, no essential change is introduced into practical optics by the new materials. Although a slight increase in the aperture is obtained, at least in comparison with that which has hitherto been advantageously employed with objectives for systematic work, yet *this* advantage is comparatively too small to be referred to as of decided importance. A substantial practical gain can only be expected from the internal perfection of the construction in the matter of the collection of the rays. Everything, therefore, is reduced to the question how far the visible action of this perfected construction which was indicated at the outset can be practically utilized in the Microscope, and herein are included the more complete utilization of aperture, or the reduction of the difference which has hitherto always existed between the theoretical and practical performance; the greater precision and distinctness of perception which is without doubt secured by the more complete collection of the rays; and, finally, the essentially more favourable conditions which are introduced in the operations of photo-micrography.

Whatever may prove to be the final result, the principle of construction of objectives as here developed must in any case lay claim to a certain interest from the purely optical point of view, as regards the essentially higher *order* of collection of rays which is realized by it.

In the language of dioptrics this order is determined by the number of rays *different* in direction of incidence or in refrangibility, which, in virtue of the conditions fulfilled by the optical system, are *completely* united in a single point in the axis.

Upon the number of these rays depend the greater or less limits within which the other rays may vary which are not completely, but only approximately united; and these limits are a natural measure of the more or less complete concentration of the rays altogether.

In this sense an ordinary simple glass lens represents a collection of the rays in its axis of the first order. The objectives of the large telescopes which are made now, exhibit for the most part a concentration of the third order, and it is only those telescopes which are made strictly after the Fraunhofer or the Gauss type of construction which attain the fourth order.

Now of the Microscope objectives which are here considered, those with the greatest aperture in the different classes have a concentration

of rays of not less than the eleventh order; *three* different kinds of rays are brought under strict conditions by the removal of colour-deviation, including secondary dispersion; *six* by the elimination of spherical aberration and its chromatic difference with such large aperture; and, finally, *two* more by the production of equal magnifying power for the different zones of the free opening. To this corresponds the enormous size of the free opening which is employed with Microscope objectives as compared with telescope objectives; whereas in the latter an opening which is only the tenth *part* of the focal length is quite exceptional, at least in the larger instruments, the Microscope objective of the present time requires openings the diameter of which are 2·8 *times* the focal length.

Eye-pieces.

The following out of the rules above indicated for the construction of objectives, has naturally given rise to increased requirements in the case of the eye-piece, which have not been hitherto taken into account, and the satisfaction of which has led to several new contrivances. With respect to these, the following considerations have been determinative.

In the first place, if the advantage of the new objectives which was pointed out above is to be realized, the eye-pieces to be combined with them must conform to the condition that they should be sufficiently achromatic in regard to the distance at which the differently coloured rays are united, whilst with respect to magnifying power they should behave as strongly *over*-corrected lenses, and the degree of over-correction should be quite definite, being determined by the corresponding deviation of the objectives of large aperture. To satisfy this quite unusual requirement, that the focal *length* of such an eye-piece must differ for different colours in exactly the opposite way to an ordinary un-achromatic lens, no special difficulties are experienced in practical optics, and the object may be attained in the different types of construction by known means. Eye-pieces of this kind *compensate* for the chromatic difference in magnifying power of the objective, and they do this at the same time for different objectives if, as was said above, the latter are equalized so that this difference is the same for all. Having regard to this property, the eye-pieces in question are called *compensation eye-pieces.*

In the second place the demand, that with the new objectives a high magnifying power in the eye-piece should be provided for systematic work, requires a considerable alteration in the construction of the stronger eye-pieces so as to free them from the disadvantages by which they are at present beset. The types of eye-piece which have been hitherto used, both the ordinary Huyghenian and the different achromatic eye-pieces, if their focal length falls much below 25 mm., require eye-lenses of very small diameter, and moreover, with them the eye-point lies very close to the lens. On this account the observer must bring his eye inconveniently near, and in particular the use of the camera lucida is prevented. By a type of construction which is essentially different from the forms in use, the compensation eye-pieces may be rendered quite as convenient for the higher powers as is the case with the weak and

medium eye-pieces now employed. The diameter of the eye-lens is considerable, and the eye-point is so far from the lens *that the camera lucida may be used without any difficulty.*

Thirdly, the endeavour to realize as far as possible the advantage of an objective of relatively greater focal length, which was before indicated, has given occasion to extend the series of eye-pieces downwards also, below the present limits, so that for one and the same objective a very large variation may be given to the magnifying power. For this purpose two special eye-pieces of unusually long focal length have been made, the weakest of which produces an eye-piece magnifying power = 1 with the Continental tube, i. e. *which produces with every objective exactly that magnifying power which would be given by the objective used as a lens without any eye-piece.* These eye-pieces may appropriately be termed "*Searcher eye-pieces,*" because they are adapted not so much for systematic observation as for a preliminary view of and *search over* the object. Including these searcher eye-pieces, the whole series gives to each objective a range of useful magnifying power varying from 1 to 18, so that for example, a homogeneous-immersion objective of 3 mm. focal length, which gives a magnifying power of 1500 with the strongest eye-piece, when used with the weakest yields only the small magnifying power of about 80.

In the above discussion frequent use has been made of a method of characterizing the eye-piece by the ratio of the total magnifying power of the Microscope to that of the objective. The author has elsewhere established this method for determining the action of the eye-piece in the Microscope.* Attention may, however, here be called to the practical advantage of the method as a basis for a rational *designation of eye-pieces.*

If the combination of objective and eye-piece in a Microscope produces a linear magnifying power N, referred to the conventional image-distance l, this expresses the fact that under these conditions the Microscope *as a whole* forms a lens-system of focal length $f = \frac{l}{N}$. Then for every system of lenses, whatever its construction, $N = \frac{l}{f}$, and thus a definite value of N results *by virtue of* a definite value of f. To discover what proportion of the magnifying power of the whole Microscope belongs to the eye-piece, it is necessary to compare the instrument as it is *with* the eye-piece with what it would be *without* the eye-piece. In the latter case it is a system of lenses (the objective) with any other greater focal length F. The ratio between this focal length and that of the whole Microscope is therefore a numerical expression of the *eye-piece action in* the Microscope. This ratio is

$$\frac{F}{f} = \frac{F}{l} N = \frac{N}{\left(\frac{l}{F}\right)},$$

* See this Journal, 1883, p. 791 *et seq.*

and since here $\frac{l}{F}$ denotes the magnifying power n which would be obtained from the objective alone, it follows that the total magnifying power of the Microscope should always be compared with the *proper* magnifying power of the objective, although the latter is not generally made use of, since Microscope objectives are not also used as lenses.

The division of the action of the whole Microscope between objective and eye-piece is therefore shown by the formula

$$N = n \, \nu ;$$

where ν denotes the quotient $\frac{F}{f}$, the measure of the action of the eye-piece.

As the author has shown, the ratio $\nu = \frac{N}{n}$ determines at the same time the whole influence which is exercised by tube and eye-piece upon the character of the microscopic image. If in any Microscope the total magnifying power N exceeds the magnifying power n of the objective, say tenfold—as for example, if with an objective of 5 mm. focal length, of which the magnifying power determined in the usual way is only 50, the total magnifying power is brought to 500—then this number $\nu = 10$ denotes the whole optical conditions on which the character of the image under these circumstances depends. In particular, it is made clear that all faults of image formation which originate in the objective will be magnified exactly tenfold in the final image, whether this tenfold enlargement is produced by a long tube and weak eye-piece, or the reverse.

Now in practice, it is of considerable interest to be always reminded of this important factor in the use of the Microscope, and this can be accomplished if the designation of the different eye-pieces expresses directly the *super*-magnifying power which they produce. There is also here the further advantage that the total magnifying power is at once obtained by multiplying the number of the eye-piece by the proper magnifying power of the objective, which is given by its focal length.

This designation of the eye-pieces is adopted with the new constructions. Each eye-piece is denoted by a number representing the super-magnifying power which it gives to the Microscope with the normal length of tube for which it is constructed. Having regard to the prevalent confusion in the designation of eye-pieces, it would be a great advantage if opticians in general would adopt this method of rational notation.

In this system, of course an eye-piece can only have a *definite* magnifying-power number so far as it is used with a definite length of tube, because the action of an eye-piece depends not upon its focal length alone, but also upon its distance from the objective. The ratio $\frac{N}{n} = \nu$ employed above is always determined by the value of the quotient $\frac{\Delta}{\phi}$, where ϕ denotes the focal length of the eye-piece, and Δ is the dis-

tance between its lower focus and the upper focus of the objective, i. e. the "optical" tube-length. One and the same eye-piece will therefore give different *eye-piece* magnifying powers—just as it gives different values of the total magnifying power—according as it is used with a short or long tube, and these vary in exactly the same proportion as the distance Δ. Such alterations, which are produced in using the Microscope by pushing in or drawing out the tube, can be determined as regards their influence upon the *eye-piece* magnifying power just as readily as their influence on the total magnifying power. If it is known that the magnifying power ascribed to an eye-piece refers to an *optical* tube-length of say 180 mm., it is also known that an elongation of the tube by 20 mm. will raise the magnifying power of the eye-piece in the ratio of 180 : 200. In order to take account of all such alterations, it is only necessary that there should be given by the optician, or determined by the observer himself, the distance between the upper focus of the objective and the under focus of the eye-piece for that length of tube which is adopted as the *normal* length. If this is unknown it will be also impossible to determine the change produced in the total magnifying power of the Microscope by a change in the length of tube.

Contrivances for Projection.

To gain a complete idea of the advantages secured for photomicrography by the apochromatic objectives, special attention is finally directed to the means of projecting the image.

The methods hitherto employed for this purpose are all beset by considerable drawbacks. The simplest and apparently the surest plan, the direct projection of the image upon the photographic plate, always leads in the case of objectives of considerable aperture, to a deterioration of the image by spherical aberration as soon as the distance of the plate is much greater than the normal length of tube for which the objective is corrected. If the distance of the plate is great, these aberrations which are produced by the altered path of the rays in the objective cannot be entirely removed even by the correction-adjustment. It is true that these sources of error are eliminated by the projection of images with an eye-piece; but the ordinary eye-pieces, especially the unachromatic, lead for their part to other considerable errors, since they largely increase the difference of focus of the chemical rays. The use of an achromatic dispersive lens (amplifier) in place of an eye-piece, which has hitherto led to the relatively best results, introduces, apart from other objections, minute and troublesome manipulation in the adjustment, if a good correction of the objective is to be secured.

The method employed by the author, which disposes of these defects, seeks to produce the objective image under the same conditions and at the same point of the tube as with eye-piece observation, and then to project this image upon the plate (or a screen) by means of *a system of lenses accurately corrected for spherical and chromatic aberration*, which can be focused to the objective image in the tube.

This method makes it absolutely certain that the objective as corrected (by means of the correction-adjustment) for the eye, remains in exactly the same condition when the image is projected, and that

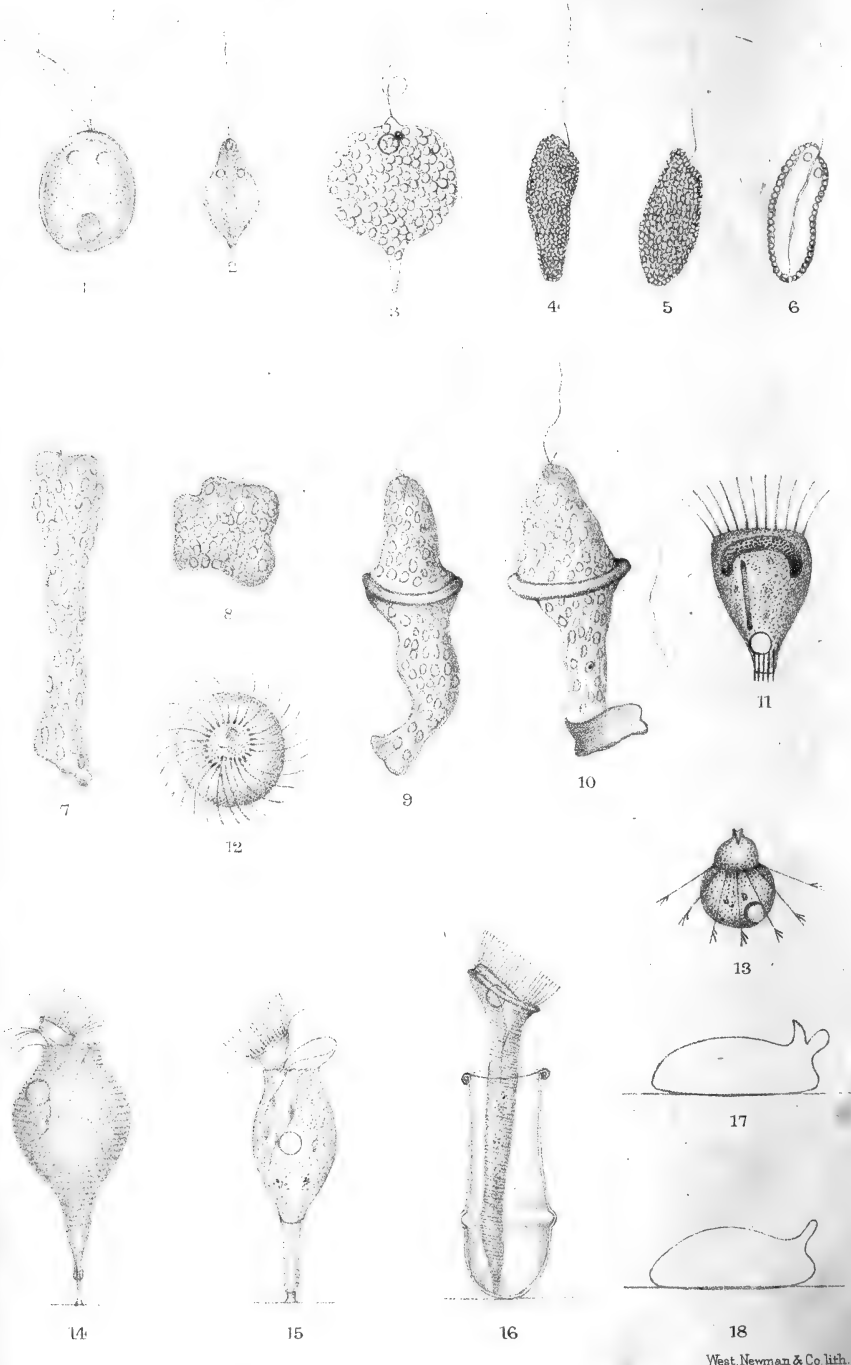
by the projection no new errors are introduced, since the projection system is corrected as well as the objective, and in particular is free from secondary colour dispersion and the focal difference which results from it.

In addition, care is also taken that in the final image the chromatic difference of magnifying power in the objective image is removed with the projection system just as it is with the compensation eye-pieces.

The whole manipulation for focal adjustment can be managed as well for short as for long distances of the plate, and is in this method particularly simple.

Such systems for projection, which are in external form like eye-pieces, and are attached to the Microscope in the same way, are designated *projection eye-pieces.*

The results already obtained by experienced photomicrographers by the employment of this method make it probable that it will come into general use in the future.



American Fresh-Water Infusoria.

IV.—*Notices of new American Fresh-water Infusoria.*

By Alfred C. Stokes, M.D.

(*Read 12th January*, 1887.)

Plate V.

The ponds, marshes, and stagnant pools of the central portion of the eastern United States seem particularly favoured by the Infusoria. Within their shallows, beneath the shadows of their aquatic vegetation, or clinging to submerged leaflets, to floating objects, or to the nameless fragmental debris at the bottom, Infusoria abound in remarkable profusion. The student of these minute but charming forms of animal life has only to sweep his collecting vessel among the water-weeds, or gently scrape the soft ooze, to be amply rewarded, not only by Infusoria whose beauty shall stir his æsthetic nature, but with forms that will fill him with wonder at their variety of structure, movements, and habits. And another source of interest, if not of surprise, is that so great a proportion of the captives are new to science. To find Infusoria in American ponds and shallow pools that have also been found in European fresh waters is not common. There are cosmopolitan forms even in sweet water, but according to my somewhat limited experience, they are not abundant. What the American margins of the sea may reveal to the Microscope I do not know. It has never been my good fortune to be able to examine a drop of the ocean with Infusoria as the objects, and as far as I am aware, that field is here practically unexplored by any one.

In the neighbourhood of the writer's home in central New Jersey the level surface of the country is only at irregular intervals sufficiently hollowed to retain the water and produce permanent pools that shall resist the summer sun, but these little depressions are abundant; consequently marshy places, small lakes, and almost stagnant pools choked with *Sphagnum* are easily accessible, and wondrously rich in the lower forms of microscopic animal life. Rhizopoda, Infusoria, and aquatic worms abound, to say nothing of diatoms, desmids, and fresh-water algæ. It is from this limited but prolific region that the writer has taken the following hitherto undescribed Infusoria among many others. All the genera here referred to were originally discovered and described by

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EXPLANATION OF PLATE V.

Fig. 1.—*Tetraselmis limnetis* × 1100.
„ 2.—*Petalomonas pleurosigma* × 750.
„ 3.—*Chloropeltis monilata* × 585.
„ 4, 5, 6.—*Chrysomonas pulchra* × 675.
„ 7, 8, 9, 10.—*Zygoselmis mutabilis* × 170.
„ 11.—*Strombidium gyrans* × 360.
„ 12.— „ „ front view.
„ 13.—*Mesodinium fimbriatum* × 562.
„ 14.—*Pyxidium vernale* × 450.
„ 15.— „ *invaginatum* × 420.
„ 16.—*Vaginicola annulata* × 245.
„ 17.—*Lagenophrys labiata* × 486.
„ 18.— „ „ with closed lips × 486.

European observers, but these members of the genera have thus far been observed only in that part of America occupied by the United States, over which they are doubtless widely distributed. It has seemed preferable to describe their characters as concisely as possible, rather than to occupy space by the refinements of rhetoric, and so complicate subsequent reference and comparison.

Tetraselmis limnetis sp. nov., plate V. fig. 1.

Lorica broadly oval, the length but slightly exceeding the width, both extremities evenly rounded; body of the inclosed zooid almost entirely filling the cavity of the lorica, the endoplasm green, granular, with a small, colourless, transparent spot at the anterior border; flagella four, each exceeding the lorica in length; contractile vesicles two, small, situated one on each side of the frontal clear space; nucleus not observed; a large, subspherical amylaceous corpuscle posteriorly located. Length of lorica 1/1800 in. Habitat, pond water.

This is only the second known species of the genus.

Petalomonas pleurosigma sp. nov., fig. 2.

Body suboval or ovate, depressed, less than twice as long as broad, widest centrally, tapering towards both extremities, the anterior margin narrowly rounded, the posterior prolonged as a short, obtuse acumination; lateral borders more or less sigmoid; dorsal and ventral surfaces each traversed by a narrow, subcentral, longitudinal depression or furrow, which usually do not extend into the caudal acumination; oral fossa distinct, the flagellum apparently originating from one of its walls, and exceeding the body in length, the distal extremity alone undulating; nucleus and contractile vesicle distinct, situated opposite each other near the lateral margins of the anterior body-half. Length of body 1/1500 in. Habitat, standing pond water.

In the double sulcation of the flattened surfaces this form resembles *Petalomonas disomata* Stokes, but is readily distinguishable by the posterior acumination, the sigmoidal lateral margins, and the smaller size.

The writer, in the 'Annals and Magazine of Natural History' for February 1886, described an infusorian under the title of *Paramonas alata*, with a diagram. It is scarcely necessary to state that the generic name should have been *Petalomonas*, as the indurated and carinated cuticular surface at once relegate the animalcule to the latter position.

Chloropeltis monilata sp. nov., fig. 3.

Body broadly ovate or subcircular, strongly compressed, about one and one-half times as long as broad; general cuticular surface not ribbed but entirely covered with conical, rounded elevations arranged more or less in longitudinal series; caudal prolongation straight or slightly curved, forming less than one-fourth the length of the entire body; flagellum not exceeding the zooid in length; eye-like pigment-spot usually present; contractile vesicle conspicuous, anteriorly located. Length of body 1/650 in. Habitat, standing pond water.

This conspicuously differs from *Ch. hispidula* (Eichwald) Stein (the

only previously known species with a roughened cuticular surface), by the absence of a distinctly ribbed superficies, those longitudinal elevations in the European species being strongly hispid. In the present form the cuticular prominences are scattered over the general surface as well-marked conical monilations arising from rounded bases.

Chrysomonas pulchra sp. nov., figs. 4, 5, 6.

Body elongate ovate or obovate, somewhat flexible and changeable in form, three times as long as broad, tapering and slightly constricted posteriorly, curved toward one side anteriorly, the frontal border obliquely excavate; cuticular surface entirely covered with small, hemispherical elevations; flagellum scarcely equalling the body in length; contractile vesicle double, small, spherical, situated opposite to each other near the frontal border, and contracting alternately; nucleus ovate, occasionally becoming very conspicuous. Length of body 1/900 to 1/650 in. Colour, green. Habitat, marsh water, with *Sphagnum*.

This infusorian has the power to make conspicuous and quite rapid changes in its shape, the body at times becoming remarkably plastic; but this ability is seldom exercised to any extent greater than the assumption of an ovoid or subspherical form.

In figs. 4 and 5 are shown two forms of the body; in fig. 6, the infusorian in optic longitudinal section.

Zygoselmis mutabilis sp. nov., figs. 7, 8, 9, 10.

Normal contour of the body apparently elongate ovate, sub-cylindrical, but extremely soft, and incessantly and most irregularly changeable in form; surface longitudinally striate; flagella two, unequal, the longer equalling the extended body in length, the shorter about one-third as long; both apparently arising from the short, conical, oral fossa; endoplasm filled with dark-bordered, colourless corpuscles of various sizes. Length of the fully extended body 1/100 in. Habitat, standing water from the cypress swamps of South Florida.

The incessant alterations in the form of this curious infusorian are indescribable. The metabolic movements are seemingly endless, the endoplasmic corpuscles rushing from end to end of the body as it extends, contracts, twists, and contorts itself. In figures 7, 8, 9, and 10 a few of these changes are shown.

The food is indiscriminately animal or vegetable. The endoplasm of the individuals observed contained desmids, diatoms, and in a single instance, a small rotifer.

Strombidium gyrans sp. nov., figs. 11 and 12.

Body turbinate or obconical, less than twice as long as broad, the lateral border of the frontal margin with a conspicuous rounded elevation, the posterior extremity tapering and truncate; cuticular surface smooth, except at the posterior region, where there are a few longitudinal ridges which often extend slightly beyond the termination of the body; contractile vesicle apparently double, one large and situate laterally near the posterior extremity, the other (?) smaller and near the frontal

border; nucleus long, band-like, transversely placed close to the anterior extremity. Length of body 1/450 in. Habitat, standing pond water.

The movements are extremely rapid and erratic, the animalcule darting through the water by revolution on the longitudinal axis so rapidly as to defy examination. Fortunately, however, it has the habit of temporarily attaching itself to some supporting object by means of its posterior extremity, when it becomes comparatively quiescent; but even then it rotates on its long axis. At other times it swings to and fro in the field, describing a long curved path through the water as though it were attached to the end of a restraining but invisible thread.

This infusorian may readily be distinguished from all other known species of the genus by the long, band-like nucleus, an organ of this form not having been recorded as belonging to any previously described *Strombidium.*

I have not been able to positively demonstrate the presence of two contractile vesicles. The creature's movements are so rapid and erratic, that the study is difficult under any circumstances, but to observe a small, laterally developed pulsating vacuole while the infusorian is rotating and continually carrying the organ beyond the focus, is well nigh impossible. The posteriorly located vesicle is large and seen with comparative ease.

Mesodinium fimbriatum sp. nov., fig. 13.

Body divided into two unequal, subglobose regions by a transverse groove, from which springs the girdle of setose cilia, each of these appendages being distally cut into three or more unequal branches; cuticular surface obliquely and finely striate, so that the margins of the body, when examined from either extremity, present a crenulated outline; contractile vesicle large, spherical, located at one side near the posterior extremity. Length of body 1/1125 in. Habitat, standing pond water. Movements rapidly rotatory, with frequent lateral leaps.

The distinctly fimbriated condition of the locomotive cilia at once separate this from all previously known species.

In company with this interesting form there was present a *Mesodinium* corresponding in all essential characters with *M. pulex* C. & L., a species hitherto recorded from salt water alone. The only noticeable difference was in the size, the fresh-water variety being somewhat larger than the marine. The cilia of *M. pulex* are not fimbriated.

Pyxidium vernale sp. nov., fig. 14.

Body elongate vasiform, twice as long as broad, consisting of a subcentral, subspherical region suddenly constricted anteriorly to produce a short, neck-like prolongation, and lengthened posteriorly to form a portion tapering to the pedicle and constituting about one-third of the entire length of the zooid; peristome border crenulate; ciliary disc large, considerably and obliquely exserted, bearing three ciliary circles; vestibulum extending to near the body-centre; cuticular surface finely striate

transversely; pedicle short, slender; contracted body obovate, the subspherical central region then thrown into several annulations over the posteriorly tapering portion. Length of body 1/300 to 1/346 in. Habitat, shallow pools with algæ in early spring. Solitary or few together.

Pyxidium invaginatum sp. nov., fig. 15.

Body elongate urceolate, often somewhat gibbous, rather more than twice as long as broad, widest centrally, constricted anteriorly to form a short, neck-like region, and tapering posteriorly to produce a subcylindrical prolongation forming about one-third of the entire length of the zooid, a transverse cuticular fold usually encircling the body at the origin of the posterior prolongation; pedicle very short, usually only about one-fourteenth as long as the entire body; the cuticular surface finely striate transversely; ciliary disc conspicuous, furnished with two circles of cilia; peristome border truncate, crenulate, not everted, apparently supporting a conspicuous, collar-like membrane; contracted zooid ovate, frequently nodding, the posterior prolongation always invaginate within the central body-region, and the short pedicle invaginate within the posterior prolongation; vestibulum capacious, extending beyond the centre of the body, its walls ciliate at intervals; endoplasm colourless, transparent; contractile vesicle single, spherical, near the body-centre, and apparently communicating with the vestibulum. Length of the zooid, including pedicle, 1/300 in. Habitat, pond water; attached to the rootlets of *Lemna.*

This very characteristic *Pyxidium* is readily recognizable and easily separable from all previously recorded members of the genus, by the presence of the double posterior invagination so conspicuous in the contracted zooid. The cuticular striations are so extremely fine that they can be observed with difficulty, except when under the influence of oblique light.

Vaginicola annulata sp. nov., fig. 16.

Lorica broadly vasiform, somewhat more than twice as long as wide, rounded and inflated posteriorly, the frontal region slightly narrowed, the anterior border everted and narrowly revolute, the posterior region encircled by a single annular and horizontal inflation; the inclosed animalcule elongate obconical, the length about four times the width of the peristome, projecting, when extended, for about one-third its length beyond the lorica; peristome abruptly widened, twice as broad as the body, the ciliary disc obliquely elevated; cuticular surface transversely striated; contractile vesicle single, spherical, situated near the anterior border, apparently within the ciliary disc. Length of lorica 1/204 in.; length of extended zooid 1/150 in. Habitat, pond water.

The posterior annulation encircling the lorica and the very anterior position of the pulsating vacuole distinguish this species from the other members of the genus. The zooids are frequently to be seen inhabiting the same protective sheath. The latter changes to a transparent brown colour with age.

Lagenophrys labiata sp. nov., figs. 17 and 18.

Lorica oval, depressed, the lower or adherent surface plane, the superior or dorsal aspect convex, the posterior margin rounded, the anterior bearing a short, anterior-superior, neck-like prolongation formed of two convex, horizontal and valvular lip-like extensions which open during the protrusion of the ciliary region of the inclosed zooid, and close at the withdrawal of that part, the orifice oval, transversely and superiorly directed; inclosed animalcule frequently filling the entire cavity of the lorica. Length of sheath 1/540 in.; width 1/750 in. Habitat, fresh-water; adherent to the legs and body of *Gammarus* sp.

In fig. 17 is shown the outline in profile of the lorica with separated lips; in figure 18 the same with closed lips.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

α. Embryology.†

Embryonic Ganglion-cells.‡—Prof. W. His states that in human embryos, at the conclusion of the first and at the beginning of the second month of development, the cells of the spinal ganglia are bipolar. Of the two processes, that which is dorsally placed passes into the hinder column of the cord, while the ventral makes its way to the motor root-fibres to go still further in a peripheral direction in their company. The processes commence with a conical piece of attachment, but narrow to thin fibres with the character of cylinder-axes. They are not connected with the middle, but with the sides of the cell-body. The nucleus is generally excentric in position, and is succeeded by a more or less broad zone of protoplasm, from the marginal portion of which the two processes pass out in opposite directions. This stage may be regarded as preliminary to the formation of T-shaped fibres. For satisfactory observations at this stage, the ganglion must be free from connective-tissue elements, and have no special investment.

Development of the Mole.§—Mr. W. Heape, in the course of this paper, notes the early appearance of the optic grooves, the formation of the amnion first at the hinder end of the embryo, and the folding off of the head end of the embryo only. Though the optic vesicles begin to appear early, their development is soon checked, doubtless in consequence of the habits of the adult. A complete tube or neurenteric canal becomes developed posteriorly; this is the homologue of the median dorsal diverticulum of the enteron of *Amphioxus*, and it is to be noted that while it there gives rise to the notochord, it almost completely disappears in the mole before the notochord begins to be formed. As, however, the notochord becomes isolated by the ingrowth of the lateral hypoblast below the axial cells, and as it is formed

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Ber. Verhandl. Gesell. Wiss. Leipzig, 1886, p. 290.

§ Quart. Journ. Micr. Sci., xxvii. (1886) pp. 123–63 (3 pls.).

of axial hypoblast cells, there is no reason for doubting the homology of the notochord in these two animals. The mesoblast of the head is not split, and no cavity is formed there. The anus is formed in the middle of the primitive streak. The venous system is very slightly developed, and the blood-corpuscles appear to be formed directly from stellate mesoblast cells.

Influence of the vertical position on the development of the Eggs of the Chick.*—M. C. Dareste finds that when the obtuse pole of the egg is upwards the evolution of the chick is normal, but that this is not the rule when the opposite pole is the upper one. Without offering a complete explanation of these facts, he points out that the "cicatricula" of the egg is in different conditions. Whatever be the position of the egg the yellow is always uppermost, and the cicatricula in the highest part of the yellow. When the narrow pole is the higher the cicatricula is in contact with the shell, from which at one time it is only separated by the vitelline membrane. When the obtuse pole is superior, the cicatricula is in contact with the lower wall of the air-chamber, which has a flexible wall.

Nucleus in Frog's Ovum.†—Dr. G. Thin describes conditions of the nucleus in the ova of *Rana temporaria* between the stages of division into four segments and that of the appearance of the morula condition; sections were made from eggs hardened in bichromate of potash and stained with picrocarmine; these methods were not such as to enable the nuclear network to be satisfactorily made out.

In the first stage observed—or that of a "tablet-nucleus"—an unformed substance was found infiltrating the yolk in certain parts of the segments. Then came the diffuse granular nucleus in which minute yolk tablets were found in the carmine-stained nuclear area; in the homogeneous nucleus the nuclear substance stains homogeneously in carmine, has distinct boundaries, and no yolk tablets or pigment. The fourth stage is that of the shrunk nucleus, in which a crescent-shaped shrivelled homogeneous substance represents the nucleus. Fifthly, simple holes were found which appear to correspond to the position of nuclei. The author gives a short account of the division of the nucleus, of the pigment, and of the pigment in relation to the segment. Pigment has no causal relation in the nuclear changes.

Embryology of Teleostei.‡—Herr H. F. Wenckebach reports the result of some studies on the development of Teleostean embryos, and especially of *Belone*.

1. *The periblast nuclei.*—According to Hoffmann the first segmentation in Teleostei is parallel to the axis of the ovum, and the upper nucleus divides to form the blastoderm, while the lower divides into the free nuclei of the subjacent protoplasmic layer—the periblast. According to Agassiz and Whitman, however, these last nuclei arise from the marginal cells of the blastoderm. Wenckebach's results go to show that the free periblast nuclei always originate from the blastoderm, either (1) from the marginal cells, or (2) from cells which fall from the lower surface of the blastoderm on to the floor of the segmentation cavity, there fusing with the periblast. The author notes the various relative researches of Ryder, Brook, Cunningham, &c., as to the origin and history of the periblast. In relation to the parablast theory of His, Wenckebach notes that as far as the

* Comptes Rendus, ciii. (1886) pp. 696–7.
† Report Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 1069–71.
‡ Arch. f. Mikr. Anat., xxviii. (1886) pp. 225–51 (2 pls.).

Teleostei are concerned no nuclei or cells arise in the periblast or in the yolk, and that the nuclei of the periblast, after their separation from the blastoderm, degenerate, and take no direct share in the formation of the embryo.

2. *The development of heart and blood-vessels.*—After the ventral closure of the gut, a band of mesoderm cells is observed close behind the optic vesicles on the lower surface. They arise from the indifferent mesoderm cells of the head which wander round the gut. The mass of cells splits to form a kind of pouch or sac—the incipient heart. He lays special emphasis on the *rôle* of these actively wandering mesoderm cells, not only in forming the heart, but also the vessels and other parts of the embryo. The similarly mesodermic origin of the blood-vessels is noted, and the history of both heart and vessels is briefly discussed. It is important to note that the heart grows as an open bag into the segmentation cavity, and its lumen is nothing else than part of the blastocœl. So too are the three main yolk-vessels parts of the blastocœl. The relation of this fact to Bütschli's theory of the metazoan vascular system, as well as to such points as the blastocœle origin of the proboscis-sheath cavity and vascular system in Nemerteans is briefly noted.

3. In regard to the much disputed *origin of the blood*, Wenckebach maintains at least that it is of purely mesodermic origin, and that neither endoderm nor free periblast nuclei share in its formation.

Relation of Yolk to Blastoderm in Teleostean Fish-ova.*—Mr. G. Brook briefly traces the development of a teleostean ovum from its origin in the germinal epithelium. The excess of nutriment supplied by the follicle is stored up as yolk in small masses. He points out the difference in the relative distribution of protoplasm and yolk in the pelagic group of ova on the one hand, and the herring and others on the other. In *Trachinus*, belonging to the former group, even while segmentation is in progress there is always a thin film of protoplasm around the large single yolk-sphere, and he compares it to a fat-cell. He draws attention to the difference between holoblastic and meroblastic ova, and shows that the real difference is not in the proportion of yolk to protoplasm, but in its distribution; and this necessitates a different mode of assimilation. It is through the agency of the parablast that this takes place, i. e. the portion of the germinal protoplasm which is not included in the germinal disc. So long as there is naked protoplasm around the yolk intracellular digestion can take place, and the protoplasm elaborated from the yolk necessarily takes a share in the formation of the embryo.

Origin of Pigment-cells which invest the Oil-drop of Pelagic Fish-embryos.†—In his examination of the embryos of *Scomber scomber* Mr. J. A. Ryder noticed that before the tail had become prominent pigment-cells began to appear on the side of the oil-drop; around the latter was a layer of protoplasm, continuous with the periblast enveloping the yolk. The periblast is hypoblastic; and the only source of the nuclei of the pigment-cells must be the periblast; therefore these cells are hypoblastic in origin.

Segmentation of Selachian Ovum.‡—In studying the development of Selachia Prof. J. Kollmann observed the persistence of segmentation, at a late stage, on the floor of the segmentation cavity and in the adjacent layer of the yolk. This has been observed by Kupffer in reptiles, and by Gasser in birds. The stages observed were those with oval germinal disc before differentiation of layers, and those with round disc and axial differentiation.

* Proc. R. Phys. Soc. Edinb., ix. (1886) pp. 187-93.
† Amer. Natural., xx. (1886) p. 987.
‡ Verhandl. Naturf. Gesell. Basel, viii. (1886) pp. 103-5.

The cells appeared to Kollmann true segmentation cells. They never arise from yolk-spheres, which are always disintegrated near the embryo. A radial arrangement of the protoplasm round about the nuclei was distinctly observed, and cell-complexes undoubtedly result. They are not undefined elements arising from the yolk or from the primitive lymph of the segmentation cavity.

The yolk-spheres never have nuclei, nor is the yolk penetrated by protoplasmic filaments. They consist simply of nutritive material and are gradually assimilated. Not only the yolk, but all contents of the ovum have to be modified and reconstituted before forming part of the embryo, and on this fact Kollmann lays considerable emphasis.

Ovarian Ovum of the Dipnoi.*—Mr. F. E. Beddard finds in the ovary of *Lepidosiren* two kinds of ova which follow a different course; one is of the ordinary type, the other consists of a number of distinct cells, and appears to have no germinal vesicle; in *Ceratodus* the second kind of ovum is found, but seems to be very rare.

Alternation of Generations in Mammalia.†—In reference to the reproductive relations of *Praopus*, of which a report has already been given,‡ Dr. H. v. Ihering communicates some suggestive notes on alternation of generations. In *Praopus* eight embryos resulted from a single germ, in *Lumbricus trapezoides* a double embryo is constant, in all groups twins may occur from one ovum;—the polar bodies are morphologically nothing less than abortive germs;—in fact, the origin of multiple embryos from a single ovum is the primitive condition, the development of only one is secondary and adaptive. Now if this be pressed to its logical conclusion, one would be forced to the paradoxical conclusion that the *Praopus*, for instance, brings forth grandchildren, and that the mother of twins from one ovum is really their grandmother. The categories are evidently insufficient, and von Ihering proposes the following revised scheme:—

I. Hologenous development (Häckel's hypogenesis). The fertilized ovum developes with or without metamorphosis into a *single individual.*

II. Merogenous development. The fertilized ovum developes into *two or more individuals*, which

 (A) return directly to the parent form and mode of reproduction (*Temnogenesis*);

 or (B) exhibit an antithesis of diversely reproducing individuals or generations (*Metagenesis, or Alternation of Generations*);

  (*a*) *calycogenesis*, in *Salpæ* and *Medusæ;*

  (*b*) *pædogenesis*, in *Cecidomyiæ;*

  (*c*) *heterogenesis*, in which either both generations reproduce sexually, or one or several multiply parthenogenetically.

Experimental Investigation of Fertilization.§—Prof. R. Hertwig reports some of the results of experiments carried on by himself and his brother Prof. O. Hertwig as to the effect of different reagents on the process of fertilization. The reagent discussed is chloral hydrate; the elements experimented on were those of *Strongylocentrotus lividus.*

* Zool. Anzeig., ix. (1886) pp. 635–7.

† Biol. Centralbl., vi. (1886) pp. 532–9.

‡ See this Journal, 1886, p. 765.

§ Anat. Anzeig., i. (1886) pp. 11–16. Cf. also SB. Jenaisch. Gesell. f. Med. u. Naturw., 1886.

(1) Even after accomplished impregnation, the above reagent hinders the normal conjugation of the male and female nuclei. They form division-figures for themselves and divide, but not normally. (2) Maturation and fertilization are associated with fundamental protoplasmic changes. The ovum-nucleus becomes differentiated into fibrils only in the fertilized egg, and the sperm-nucleus in an unripe ovum remains either wholly unchanged or becomes a watery vesicle. Hertwig raises the further questions (*a*) of the possibility of fractional fertilization, and (*b*) as to the actual factors by which the two nuclei are brought together.

Importance of Sexual Reproduction for the Theory of Selection.*— The main aim of Prof. A. Weismann's recent essay on this subject is to establish the position that the process of sexual reproduction is the prime agent by which all the varied differentiations of the complicated phyla of the Metazoa have been brought into existence. It is urged that peculiarities acquired by the parent are not transmitted to the offspring, and that the hypothesis that such acquired peculiarities are transmitted is not necessary for the explanation of the known phenomena of heredity. Characters can only be said to be acquired, the origin of which is due to external influences; if these cannot be transmitted, it is clear that those only can which were present in the germ at the time of its formation. "There are no facts which really prove that acquired characters can be inherited, although many attempts have been made to render such a supposition plausible"; the fact that children of civilized parents, if isolated, show no trace of a language, is cited in this connection. As against the well-known experiments of Brown-Séquard—the hereditarily epileptic guinea-pigs—it is urged that epilepsy is no morphological peculiarity, but a disease. If the epilepsy be due to a microbe, then we can imagine that the microbe might be transmitted with the sperm- or ovi-cell.

The germ-plasma, though immensely complex in its finest structure, has a remarkable power of persistence; as it can remain unchanged it is obvious that it is not easily to be modified. Hereditary individual varieties are to be explained by the fusion of two antithetic germ-cells, or possibly nuclei only; the process of mingling is the cause of the occurrence of hereditarily transmissible individual peculiarities, and it is the production of these peculiarities which it is the office of amphigonic (or sexual) reproduction to effect.

This "startling conclusion" is further elaborated, and is shown to be consistent with a large number of known facts, and accepted generalizations. The author considers that he has plainly shown that the selection theory is by no means incompatible with the conception of the continuity of the germ-plasma, and that he has made sexual reproduction to a certain extent comprehensible.

Chemical Comparison of Male and Female Elements.†—Prof. O. Zacharias has obtained some interesting and suggestive results from the micro-chemical comparison of male and female elements in Characeæ, Mosses, Ferns, Phanerogams, and—Amphibians. In the cases investigated the male cells were distinguished by their small or absent nucleoli and by their rich content of nuclein, while the female elements exhibited a poverty of nuclein, an abundance of albumen, and one or more nucleoli more or less large in proportion. The latter were not distinguishable from the

* Weismann, A., 'Die Bedeutung der Sexuellen Fortpflanzung für die Selektions-Theorie,' 8vo, Jena, 1886. Cf. Prof. H. N. Moseley in 'Nature,' xxxiv. (1886) pp. 629-32.

† Biol. Centralbl., vi. (1886) p. 250 (Ber. 58 Versamml. Deutsch. Naturf Strassburg, 1885).

nucleoli of other nuclei. No nuclein was demonstrable in the protoplasm of the cell. The male cells have in proportion to their mass of protoplasm a larger nuclear mass than the female cells. The fertilized ovum has thus, in proportion to its other contents, more nuclein than the unfertilized. In the unfertilized egg-cell large quantities of nuclein are probably present in extremely fine distribution. In this connection, Strasburger suggests that parthenogenetic ova may be found to be characterized by relative preponderance of nuclein.

Primitive form of Metazoa.*—Prof. W. Salensky contributes an interesting and suggestive discussion of the much debated question as to the nature and origin of the primitive Metazoa. His chief conclusions are summed up as follows:—

1. The primitive form of Metazoa, or more precisely, of the Heteroplastids, may be regarded as a Volvox-like vesicular flagellate colony, nourishing itself in animal fashion, reproducing like a *Volvox*, and exhibiting like it certain individual deviations in its development.

2. From the vesicular primitive form, in the course of the premature liberation of a series of generations, a gastrula results, in which the germinal cells are partly modified into endoderm, and partly persist as they were, so that the primitive genital cavity (genitocœle of Salensky) becomes enteric + genital or a phagogenocœle. This genitogastrula form is provided with an opening.

3. The gut-cavity of the Metazoa is homologous with the brood-cavity or genitocœl of the primitive form. The blastocœl of the Metazoa is a new formation, which only becomes properly developed in the true Metazoa.

4. The blastopore is the homologue of the primitive aperture of the Volvox colony. Its closure is nothing but a reminiscence of the closure of the Volvox aperture.

5. Different forms of blastula are not homologous with one another. Schizoblastulæ are nearest the primitive form. Gastroblastulæ are derived from the primitive type by a process of accelerated differentiation.

β. Histology.†

Studies on the Cell.‡—Herr R. Altmann states that he finds in the cells of animal tissues small bodies, which he calls granules; they only become visible after the tissues have been treated with xylol, alcohol, colouring matter, picric acid, alcohol, bergamot oil, and xylol balsam in succession. The granules are present in large numbers, and appear to increase by division, though it is not certain whether this is the only mode. The author compares them to the lowest organisms, bacteria being, in his opinion, not true cells.

Fundamental Condition of Equilibrium in Living Cells.§—At the moment of formation the cell-membrane of animal and plant cells is thin and plastic, and M. L. Errera points out that it is in the condition of a soap-bubble, and is, like it, so light that the action of gravity may be neglected, and that it arranges itself consequently only under the influence of molecular forces. Admitting this, it is possible to connect the architecture of cells with molecular physics.

* Biol. Centralbl., vi. (1886) pp. 514–25.
† This section is limited to papers relating to Cells and Fibres.
‡ 'Studien über die Zelle,' Heft i., 53 pp. and 1 pl., Leipzig, 1886.
§ Comptes Rendus, ciii. (1886) pp. 822–4.

Physicists have shown that a film of liquid, homogeneous and without weight, can persist only if it forms a surface with a constant mean curvature. Cell-membranes at the time of their formation fulfil this condition. Many of the lower plants (e. g. Conjugatæ) form figures of revolution, either spheres or cylinders, &c.

When a cell divides simultaneously into several others, the collection of partitions forms a "system of laminæ"; and the division of cells in endosperms and sporangia of plants fulfils, very approximately, the condition found in such systems, as to the angles at the junction of the partitions and so on. In the most usual cases of binary division the new partition is nearly at right angles to the old membranes, as Sachs has shown.

In membranes which are not homogeneous the mean curvature, instead of being constant, is at each point in inverse ratio to the tension.

Structure of Glandular Cells.*—Dr. J. H. List sums up his results as to the histology of mucous cells. He notes the distinction between the threadwork and the interfilar substance, the varied arrangement of the former, and the unequal staining of the latter, the independence of the nucleus and its frequently flattened form, &c. As the goblet-cell approaches the surface, and becomes more mature, the threadwork becomes better developed.

In the living cell subtle movement of the threadwork may be detected. The nodes seem slowly to approach one another, and then retreat. List regards as probable the suggestion of Rindfleisch, that the movement was referable to altering adhesion between the two chemically different substances.

During secretion the strands of the threadwork converge towards the mouth, while the transverse connections are for the most part broken. In the plug, expelled and disrupted meshes may be recognized, but the interfilar mass is present in much greater proportion than in the theca. Dr. List therefore suggests that an increase of volume in the interfilar mass may be the main factor in the secretion, while the threadwork remains more passive. In regard to the proportion between cell protoplasm and secreted substance, the author found that the former was completely modified at an early stage.

Goblet-cells.†—Dr. J. H. List gives a detailed account of his researches on goblet-cells. The memoir is introduced by a full historical critique of relative observation.

In describing the *form* of goblet-cells, Dr. List distinguishes those without a basal process or foot containing the nucleus, and those with such an appendage to the "theca" or body of the cell. The former are again distinguished into stalked and unstalked forms. The various sizes in different regions and organisms are tabulated.

The *content* of the theca consists of a framework, with polygonal or round meshes, and a homogeneous substance, less readily stainable, occupying the meshes. The former is distinguished as the threadwork ("Filarmasse") and the other as the "interfilary" substance. Both are described in detail. The contents of the foot are similar. The stalk appears homogeneous and sometimes granular. The author was unable to see any connection between the network of the cell and the intranuclear network. The characters of the nuclei in the different forms are described, karyokinetic figures were never observed, but multinuclear cells occurred.

* Biol. Centralbl., vi. (1886) pp. 592-6 (Ber. 59 Versamml. Deutsch. Naturf., Berlin, 1886).

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 481-588 (6 pls.).

The *secretion* occurs normally in superficial cells in which a stoma has been formed as the result of pressure and absorption. The secretion is apparently determined by what appears like a gradual coagulation. No nuclear modifications were observed. The secreted mass consists chiefly of the interfilary substance, but the threadwork was also represented. The secretion may be repeated more than once, but finally the whole cell is expelled. This degeneration is associated with epithelial regeneration, and even still functional cells may be expelled.

In regard to the *development* of the goblet-cells, Dr. List's results go to show that they are modified from epithelial cells of the subjacent layers. The very varied occurrence of the cells is then discussed. The author maintains the entire distinctness of the goblet-cell types, and the distinctions which he draws between them and Leydig's cells have already been noted in this Journal. He differs from Schiefferdecker in maintaining further their entire distinctness from the cells of mucous glands.

Some interesting facts are communicated in regard to the artificial production of goblet-like cells by the action of reagents upon ordinary epithelial cells. As to the physiological import of the cells, about which there has been so much variety of opinion, the author only commits himself to regarding them as unicellular glands of a perfectly specific character. The action of various reagents is finally noted.

Endogenous Cell-multiplication.*—M. A. Jaworowski has investigated the development and histogenesis of *Chironomus* and other organisms with special reference to the endogenous multiplication of cells.

I. (*a*) *The reproductive organs of Chironomus* arise dorsally on the ninth ring in the form of a protoplasmic mass composed of two cells and surrounded by a fine homogeneous membrane. Within each of these two cells four daughter-cells arise, and the endogenous method of multiplication is constant. Each ovarian tube is primitively spherical; it elongates gradually by the formation of new cells at the anterior pole, and is successively constricted at the limit of each new centre of development. The thread-like tube which results contains protoplasm and cells which give rise to the terminal filament of the ovarian tube. The centre of each constriction is occupied by a cell increasing at the expense of its neighbours and forming the ovum. The author maintains that the ovarian tubes of vertebrates are similarly formed.

(*b*) *Muscular sheath of the ovarian tubes.*—Among the mother-cells which give rise to the ovarian tubes there is a portion of residual protoplasm of the primitive cell. This always forms little nucleated cells which become muscle-fibres. These elongate in all directions, and form a single-layered muscular network round the ovarian tubes.

(*c*) *The terminal filaments and the efferent ducts* are then described, without, however, establishing much that is new. From a single primitive cell, according to Jaworowski, the entire organ arises. All the cells—ovules, epithelial, and vitelline—are homologous. The latter never serve to nourish the ovules except in a wholly indirect way.

(*d*) *The egg-envelope* is not due to peripheral ovules or epithelial cells, but solely to the surrounding protoplasm of the primitive cells. The epithelial cells only form markings on the envelope. The author, in concluding his detailed survey of the development of the reproductive organs, refers the *rapid death* of the insects after egg-laying or sperm emission to the fact that the abdominal cavity, distended with reproductive elements, cannot retract immediately after the expulsion of the latter, and

* Arch. Slav. de Biol., i. (1886) pp. 641–51, from Ann. Acad. Sci. Cracovie, 1885.

becomes replete with blood which cannot re-enter the circulation. The *pædogenesis* M. Jaworowski refers to the rupture of the incompletely developed ovarian membrane, and the liberation of ovules into the body-cavity, where amid richly nutritive environment, they are able to develope into larvæ without fertilization.

II. The author next describes the development of the vascular system in the chick, &c. His results differ considerably from those generally accepted. The cells of the mesoderm are not distinctly separate, but bathed in protoplasm. Some of them, instead of dividing and separating, form multicellular endogenous vesicles. The protoplasm of the peripheral layer collects at certain points and forms pseudopodia, which penetrate among the other mesoderm cells. One of these processes becomes united with that of an adjacent vesicle; the others disappear. Meanwhile the daughter-cells of the vesicle are being arranged, some peripherally in the protoplasm, and others centrally. The former become elongated, flattened, and connected to form the walls; the latter form the blood elements. The development of the heart is essentially similar.

He sums up his conclusions as follows:—(1) That the membrane of mesoderm cells is primitively formed of a network of ramified cells, multiplying and elongating in all directions, and finally flattening out to form an apparently homogeneous membrane; (2) that the nucleus is a daughter-cell, or rather a vesicle with walls composed of granulations bound together by fundamental filaments; (3) that the nucleolus is a vesicle, and formed as a protoplasmic granule within another vesicle or developing cell, viz. the nucleus; and (4) that the protoplasm of the cell is the only formative and nutritive substance of these granules, which are in fact cell-germs. The division of the nucleus is only apparent. All nuclei arise as granules in the fundamental protoplasm.

III. *Blood in the adult organism.*—M. Jaworowski finds the same way of looking at cells and nuclei verified further in the blood of adult animals. The serum is the creative and fundamental substance. In it are developed the white corpuscles, which losing their nuclei and becoming granular form mother-cells, of which the daughter-cells may either become red blood-corpuscles or their mother-cells. The white corpuscles are mostly formed in the lymphatic system, and the author does not distinguish them from lymph cells. The mother-cells break up into daughter-cells especially under the pressure of the capillary walls. Various other questions are discussed.

IV. *Development of striped muscle.*—M. Jaworowski has studied the endogenous multiplication of cells in the developing striped muscles of fish embryos (*Alburnus*). The least developed muscular mass consisted of elongated cells surrounded by a membrane containing one or more daughter-cells, some of which are already transformed into mother-cells of the second order. He believes that an elongated primitive cell forms the entire muscle, but it is difficult to give a brief elucidation of the process; nor is one much encouraged to attempt this till the close of the memoir affords more definite information as to what M. Jaworowski means by the words vesicle, cell, and nucleus.

Cilia.*—Herr J. Frenzel has studied the histology of cilia in a considerable number of living forms, with the general result of demonstrating their complicated structure. He gives a brief historical note of the principal researches since Engelmann's classic memoir.

In many instances Herr Frenzel observed that the "basal portions"

* Arch. f. Mikr. Anat., xxviii. (1886) pp. 53–80 (1 pl.).

(" Fuss-stücke) were simple uniform rods, but provided both at their upper and lower end with a sharply defined apparently spherical knob. Viewed from the side, a row of these basal portions thus forms two parallel pearl-necklace-like lines. This has been repeatedly described as a double-contoured cuticle, which it certainly very closely resembles when the knobs are closely packed together. Modifications are not unfrequent, such as the disappearance of one or both rows of knobs. Or, again, two distinct lower rows of knobs may be present. Herr Frenzel confirms the general opinion that the cilia are continuations of the basal rods. A connecting portion, a bulb, and a lash proper were distinguishable in the cilium, but not always. In some cases eight parts might be distinguished, (1) a basal knob next the cell, (2) an inferior clot, (3) an accessory inferior knob, (4) the basal rod itself, (5) the superior knob, (6) the connecting portion, (7) the hair-bulb, (8) the shaft. These results are compared with what is otherwise known of cuticular fringes and the like. All these structures, basal rods among the rest, Frenzel regards as protections for the sensitive and otherwise naked cell.

Formation of Vacuoles in red-blood Corpuscles.*—Herr W. Nikolsky has treated blood-corpuscles with ammonium chlorate and other ammonium compounds with the following results:—(1) It seems very probable that by treatment with ammonium chlorate, &c., vacuoles may be produced in the blood-corpuscles of all animals with nucleated red corpuscles. (2) It is probable, further, that vacuoles in other cells, as described by several authorities, may have a similar origin. (3) His result points to the gaseous nature of the vacuoles. It may be ammonia or a derivative of ammonia with an organic radical. The vacuoles grow smaller and finally disappear on treatment with much chlorate of ammonium. The fact that the vacuoles disappear under the influence of acids, confirms the supposition of the basic nature of these gas bubbles.

Wandering Leucocytes in Epithelium.†—Dr. J. H. List describes the morphology of wandering leucocytes which he studied in the cloacal epithelium of *Raja miraletus.* The refractive, homogeneous or slightly granular, nucleated and vacuolated cells, varied greatly in form and size. They are very closely associated with the epithelial, round which they sometimes form a ring. In cavities between the epithelial cells a number of leucocytes were occasionally observed. Small bodies like portions of leucocytes were frequently seen. It seems possible that the leucocytes are destroyed in their migration through the epithelium.

Genesis and Death of Muscle-fibre.‡—Dr. T. G. Navalichin has studied the genesis and death of the muscles of the eye in a number of vertebrates.

The muscles of newly killed animals were put for some weeks in water slightly acidified with acetic acid. The normal union between the muscle-fibres and the tendinous strands was thus preserved intact. The following results were obtained:—(1) In the muscles of the eye, especially in young forms, the fibres are surrounded by sheaths of sarcolemma open at the ends of the fibre. The component fibrils pass by fine terminal ends into the fibrils of the tendon. (2) Among the primitive strands of the tendinous tissue, there are rows of elongated, fusiform, transparent elements, with one nucleus, or occasionally with two. These elements are connected together by fine terminal threads. In contact with the muscular tissue, however, these prolongations unite into fibrils, which project outside the gaping ends

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 437–41 (1 fig.).
† Ibid., xxviii. (1886) pp. 251–6 (1 pl.). ‡ Arch. Slav. de Biol., i. (1886) pp. 134–8

of the sarcolemma sheaths. These "myoplasts" are observed in the tissue of the external perimysium, chiefly among the muscle-bundles. As to their origin, they may be derived from the elements of the osteogenic layer of the periosteum, or perhaps from the so-called formative or plasmatic cells. (3) Among the tendinous strands and in the tissue of the external perimysium, very thin (1–2 μ) muscle-fibrils are observed. Their origin from the modification of the above myoplasts is described. The young fibre has a sheath of sarcolemma, and this seems capable of growth. The muscular fibre grows at either pole by means of new myoplasts, which become terminally connected with the muscle-fibrils. (4) This account of the origin of muscle-fibres confirms physiologically the correctness of the morphological division of fibres into fibrils. (5) The author believes that the regeneration of destroyed muscle is also effected through myoplasts. (6) Beside the normal fibres, he observed sarcolemma sheaths filled with an unstriated, more or less opaque mass. The mass contained round or oval elements, and one nucleus, or sometimes two. The muscular substance was only represented by the slightest traces. These elements correspond to the "Muskelzellenschläuche" of Waldeyer or to the "Wanderzellenschläuche" of Erbkam.

Seeking to discover the nature of these peculiar sarcolemma sheaths, the author proceeded to follow a method recommended by Rachmanmow. The limb of a young animal was ligatured for 10–12 hours by means of an indiarubber band. In animals killed within 24 hours after the removal of the ligature, it was seen that the myoplasts nearest the end of an adult fibre had not exhibited the modifications which, as above noted, serve for the increase of the muscle substance. On the contrary, the change in their nutritive relations brought about by the pressure had induced peculiar transformations. The nucleus had disappeared, the protoplasm was granular and had divided into five or six masses. The author believes that these myoplasts destroy the muscle, penetrating into the sarcolemma sheath and into the mass of the fibre, and in the abundant nutrition proliferating rapidly. (7) The "Muskelzellenschläuche" and "Wanderzellenschläuche" of other authors are these "myoplasts."

γ. General.*

Colour-sense.†—Herr Tiebe gives a useful historical account of the more important researches on the perception of colour and brightness by animals. He devotes most attention to the recent researches of Prof. Graber, who demonstrated over a wide series of forms sensitiveness to differences of colour and brightness.

Influence of Electric Currents on Tadpoles.‡—Herr L. Hermann has continued his curious experiments on the behaviour of tadpoles in a vessel through which an electric current was allowed to pass. They dispose themselves in such circumstances with their head towards the anode. He proved that this depended on the nervous rather than upon the muscular system, and was only exhibited, for instance, by portions of tadpoles containing part of the spinal cord. The experiments were varied in different ways, e. g. by inserting one of the electrodes in the immediate neighbourhood of head or tail. The result was always the same, that the ascending current produced lively movements and unrest, while the descending

* This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

† Biol. Centralbl., vi. (1886) pp. 489–503.

‡ Arch. f. d. gesammt. Physiol. (Pflüger), xxxix. (1886) pp. 414–9.

current produced quietness or, at a maximum, paralysis. Herr Hermann does not yet attempt to draw any general conclusion from his results. He notes in a postscript the clear and almost transparent appearance of the larvæ after even a short darkness, and further the presence of air in the rudimentary lungs, while the alimentary tube never contained any.

B. INVERTEBRATA.*

Minimum Temperature consistent with Life.†—In a series of experiments on about two dozen worms, Arthropods, and Molluscs, Dr. H. Roedel has extended Pouchet's well-known researches as to the resistance of animals to cold. His general results are as follows:—

1. Lower animals become frozen at temperatures varying greatly in the different genera and species. The resistance varies with the actual body-heat of the animal, with its size, structure, and protective covering, with the freezing-point of the blood, &c.
2. The resistance usually increases with progressive development, but sometimes the adults are more sensitive than the young.
3. Nothing can be directly inferred from the geographical distribution.
4. Perfectly frozen animals are never revivified.

He proposes a curve with the degree and the duration of the temperature as co-ordinates. These two factors must be considered together. The absolute minimum is obviously the fatal temperature in unit time. He enumerates the various results as exhibited by degeneration, cessation of certain functions, sleep-like paralysis, and death; and sums up his experiments in a tabular survey.

New Function for Invertebrate Otocysts.‡—M. Y. Delage has made a series of experiments on *Sepia* and some Crustacea (*Mysis*, *Palæmon*, and *Polybius*), in order to ascertain the effect produced on their powers of swimming by the removal of the eyes and otocysts.

He finds that the removal of the eye does not inconvenience the animal to any great extent; it will continue to swim in the ordinary way, but rather more slowly; it does not turn over on its dorsal surface, and keeps straight on its course. But on the removal of the otocyst, either with or without the eye, its course is no longer direct, but the animal turns on its axis, performs somersaults, and in fact completely loses control of its actions.

The author therefore concludes that the presence of otocysts, hitherto regarded only as auditory organs, is necessary for regulating the animal's locomotion. He points out the resemblance between his own results and those of Fleurens on rabbits and pigeons.

Function of the Malpighian Tubes of Insects and Nephridium of Pulmonate Mollusca.§—Dr. C. A. MacMunn has obtained uric acid crystals from these organs, establishing that the view held that they function like the kidney of vertebrates is well founded.

Pelagic Microzoa of the Baltic.‖—Dr. O. E. Imhof, from observations made at four stations in the Baltic, is able to confirm the view of Pouchet and de Guerne as to the connection between the pelagic fauna of the

* When a paper deals with the subjects of more than one of the following divisions it is placed here.

† Zeitschr. f. Naturwiss., lix. (1886) pp. 183–214.

‡ Comptes Rendus, ciii. (1886) pp. 798–800.

§ Journ. of Physiol., vii. (1886) pp. 128–9. See extended notice, *infra*, Microscopy β.

‖ Zool. Anzeig., ix. (1886) pp. 612–5.

Baltic and that of German (? Swiss) fresh-water lakes; of course, however, there are some species in the Baltic which are not, so far as is known, in the lakes also.

Microscopic Organisms in Fresh Water.*—Dr. G. Asper, in investigating the pelagic fauna of fresh-water lakes, finds that the most abundant forms in Lake Zurich are *Ceratium*, *Dinobryon*, *Volvox*, *Vorticella*, *Anurea*, *Polyarthra*, and *Synchæta*. The Protozoa and Rotifera considerably exceed in numbers the Entomostraca; and of the above forms, one genus will be predominant at one time, whilst at another time some other genus will exceed it in numbers. Pelagic species of *Difflugia*, and rich development of diatoms, especially *Asterionella formosa*, were also found.

Amphibious Life in Rhizomorpha.†—Dr. R. Schneider has made an investigation into the animals found living amongst the mycelia of *Rhizomorpha subterranea* in a damp grotto near Dresden; he found 51 forms, 24 of which are Protozoa, 8 Vermes, 18 Arthropoda, and 1 Mollusc; of these 30 are typically aquatic, 14 terrestrial, and 7 amphibious.

Mollusca.

Eyes of Mollusca.‡—Mr. W. Patten communicates the results of his investigation of the eyes of Molluscs (and Arthropods §). His results differ widely from those of Grenacher and other authorities, and lead to the reduction of the essential parts of all visual organs to one structural plan, which can be followed throughout the whole animal kingdom. Some difference of opinion exists as to the author's views.‖

1. *Arca.*—The eyes of the timid *Arcas*, which detect even a faint shadow cast on the water, are of three kinds—facetted, invaginate, and pseudo-lenticulate. The first are aggregate, and are confined to the anterior and posterior thickenings of the mantle edge. The invaginate eyes, forming oval pigmented cups, are smaller than the latter, and form a narrow band along the summit of that portion of the ophthalmic fold of the mantle margin, beneath the ventral opening in the shell through which the byssus projects. The third form resembles the last type, but is not invaginated, and consists of a few retinal cells, covered with a lenticular and refractive body like a cornea, or lens. They occur irregularly among the invaginate forms. There are altogether about 1300 eyes for each individual.

After a brief historical review, Patten proceeds to describe the structure of the compound eyes. They consist of 10–80 "ommatidia." Each wedge-shaped ommatidium consists of a central core of two fused cells (*retinophoræ*), whose bases are directed outward, and support a double, highly refractile rod or perceptive element. The central cells (or *retinophoræ*) are surrounded by two rows of four pigmented cover cells (or *retinulæ*). The outer end of each of these is capped by a thick layer of transparent and perfectly homogeneous cuticula. The inner, membranous prolongations consist of flattened, and longitudinally striated "*bacilli*," ending abruptly in root-like fibres. The expanded pigmented cells form a broad collar for the *retinophoræ*. The connection of the nerve-fibres with the pigment cells, and with the *retinophoræ* is then noted. A special aggregation of fibres can be seen passing along the outer surface of the latter, and they also inclose, being double, a centre bundle.

The invaginate eyes are simple thickened portions of the hypodermis,

* Arch. Sci. Phys. et Nat., xvi. (1886) pp. 366–7.
† SB. Preuss. Akad. Wiss., xxxix. (1886) pp. 883–900 (1 pl.).
‡ MT. Zool. Stat. Neapel, vi. pp. 542–756 (5 pls.). § Cf. *infra*, p. 82.
‖ See Prof. E. R. Lankester in Quart. Journ. Micr. Sci., xxvii. (1886) pp. 285–92.

sunk below the surface, forming shallow depressions or deep funnel-like pits. The eyes are each composed of the same elements as the facetted, that is, a central colourless cell, probably containing an axial nerve-fibre and two nuclei, together with a cuticular rod supporting a specialized part of the retia terminalia (the retinidium); around each of these central cells, or retinophoræ, are arranged a number of pigmented ones—in this case more than a single circle—which also support nerve-bearing cuticular rods. Each eye is described as a *retineum*, i. e. a collection of ommatidia in which the retinidia (or rods) of both retinulæ and retinophoræ, or of the latter alone, form a continuous layer, the retinulæ retaining their pigment and primitive arrangement around the retinophoræ.

The *pseudo-lenticulate eyes* are transitional. They occur as sharply defined groups of non-invaginated ommatidia, provided with a prominent lenticular thickening of the cuticula, containing nerve-fibres. A retinal cuticula is formed by the pigmented cover-cells, as well as by the retinophoræ, and hence these eyes resemble more closely the invaginated forms; on the other hand, they tend to form a protuberant convex surface, instead of a concave one.

2. After a brief notice of *Pectunculus*, Mr. Patten proceeds to the discussion of the eyes of *Pecten*. First, in regard to the general structure and function, he shows that the parts really have the function that their names and composition suggest. The movements of lens and iris are described. That the lens is really such was proved by observing the formation of perfect inverted images in the depths of the eye. They are formed by the cornea and surface of the lens, as upright and reflected images. The image falls upon the percipient rods just above the tapetum. By focusing between the argentea and the place where the image formed by the lens is seen with the greatest advantage, a double image is seen, less distinct towards the argentea, but increasing in sharpness towards the focal point of the eye, where the two images ultimately fuse to form a single one. The only explanation he has to offer for the origin of this second image, is that it is a reflected one of the first, formed by the curved surface of the argentea.

The distribution of the eyes is then considered, and an attempt made to explain the differences, e. g. between the two sides of the mantle. In those species in which the eyes are especially numerous, a number of eyes occur in which the pupils are entirely covered with pigment, but the retina nevertheless perfectly developed. (*a*) The whole *external surface* of the eye is covered with a continuous layer of columnar epithelium, increasing in height as far as the iris, where it is suddenly reduced in thickness, and losing its pigment forms the cornea. (*b*) The *corneal cells* are columnar, capped externally with cuticula, and interlocked with one another by irregular folds. (*c*) The cells of *iris* only differ from those of the cornea in being larger and filled with pigment. They serve merely to exclude the lateral rays of light from the retina. (*d*) The *stalk* consists of loose connective tissue containing enormous blood-spaces. Two groups of long striated muscle cells act as erectors and depressors. Anteriorly, they are replaced by numerous fine fibres forming a hyaline "*pseudo-cornea*" just beneath the cornea. At the edge of the iris, many fibres appear to terminate in an outward curve, as though attached to the epithelium at that point, forming the "*ciliaris*." (*e*) The *lens*, which is suspended in a large blood-sinus, consists of a modified group of mesoderm cells, continuous with those of the pseudo-cornea and connective tissue capsule. Its minute structure, and the formation of the membrane called the *suspensory ligament* are then discussed.

The lens and the corneas form the anterior, dioptric part of the eye. The posterior portion is a thick concave disc, completely inclosed in a membranous "*ommateal*" sac. The anterior wall or *septal membrane* protects the ends of the retinal cells and forms an elastic cushion for the lens. The still thicker inner wall forms the tough double *sclerotica*. The cells within the sac form a closed vesicle with obliterated central cavity. The originally simple wall consists of four layers,—(*a*) anteriorly, an outer ganglionic layer, an inner ganglionic layer, the retinophoræ, and the rods containing the retinidia, and (*b*) posteriorly, an outer vitreous network, a double argentea, and the red tapetum. (1) The *retinophoræ* form the largest and most important layer of the retina. Their outer ends, narrowed to nerve-fibres, are attached to the periphery of the retina, whence they are directed inwards towards the optic axis. Their structure and disposition is described. A delicate structureless wall separates the retinophoræ from their rods. (2) The *rods* are columnar bodies of a faint yellowish-red colour. They consist of a hyaline, refractive cap, surrounding a pyramidal core, filled with a watery, non-refractive fluid. The course of the axial nerve-fibre of the retinophoræ, and the disposition of the radiating fibrillæ which form the greater part of the rods, are then noted. (3, 4) Two other groups of cells, the *inner and the outer ganglionic layers*, add to the complication of the outer wall of the optic vesicle. The four strata are modifications of a single layer.

As to the inner wall, (1) the *vitreous network* has hitherto been overlooked. It is a very thin layer of hyaline substance, perforated by large holes in which the inner ends of the rods fit. It is a cuticular secretion of the outer layer of the argentea, and homologous with the cuticular rods secreted by the retinophoræ. (2, 3) The *argentea* is formed by the modification of two cell-layers into refractive, laminated membranes, each composed of minute square plates with bevelled edges. It is thicker in the centre of the eye, gradually diminishing peripherally to a thin layer. "While acting as a perfect reflector for incident rays passing through the lens, it offers no great impediment to the entrance of light into the retina, after passing through the colourless eye-stalk and red tapetum." (4) The *tapetum* or "red pigment layer" consists of a single layer of cells, decreasing in thickness peripherally, and ending with the argentea, where the fibres from the axial branch of the optic nerve enter the retina.

The optic vesicle, with the above eight layers, is contained in the ommateal sac. The anterior wall or *septum* of the latter forms a stout double membrane on which the lens rests. The inner wall or *sclerotica* consists of tough hyaline connective tissue, decreasing in thickness to the periphery of the retina, where it becomes continuous with the septal membrane. It is also a double layer.

The *optic nerve*, which arises from the circumpallial, extends through the centre of the stalk, and divides into two nearly equal branches. "The basal or axial branch abuts against the sclerotica, and losing its sheath, divides into many bundles of free nerve-fibres, which, clinging closely to the sclerotica, ascend radially towards the periphery of the retina, where they penetrate, in quite distinct groups, the ommateal membrane, and become continuous with the attenuated ends of the retinophoræ, through the centre of which they are extended as axial nerve-fibres. The lateral or ganglionic branch ascends towards the shell side of the retina, over which it is bent nearly at right angles, and is continued over the surface of the septum, the thick outer layer of which it penetrates just below the inner surface of the lens. Its fibres unite with the ganglionic layers, or pass between their cells to the surface of the rods."

An account is then given of the *development* of the eye in *Pecten. Inter alia*, Mr. Patten notes the occurrence of transitory pigmented cups, probably homologous with the invaginated eyes of *Arca.* At the base of the ophthalmic fold, between it and the velum, a few large cells form small oval thickenings, the rudiments of the future eye. By continued proliferation of the cells on the outer side of the optic thickening an oval knob-like papilla is formed. The proliferation continues to form a hypodermic core. At first this is not sharply defined, and several of the deeper cells separate from the rest and mingle with the numerous connective-tissue cells. They are the ganglionic cells, which later provide the eye with nerve-fibres. The optic vesicle and several of its parts are then accounted for in detail. An interesting comparison between the origin of the sense-papillæ and the origin of the optic nerves is suggested, and a future elaboration promised. The sense-hair papillæ appear as thickenings of the hypodermis similar to those of the eyes. An inward proliferation of cells forms an ectodermic core, which becomes transformed into the longitudinal nerve with which every tentacle is provided.

Patten's observations are then extended to *Ostrea*, *Mactra*, *Pinna*, *Avicula*, *Cardium*, and *Haliotis.* The chapter on Arthropods is reported on separately.* Some of his suggestive conclusions on Mollusca are summarized below.

General.—The term ommatidium is redefined by Patten to designate those constructive elements of all eyes consisting of single (?) or compound colourless cells—the retinophoræ, surrounded by one or more circles of pigmented ones, or retinulæ. A typical molluscan ommatidium consists of a double, colourless, sometimes gland-like cell, the retinophora, containing two nuclei and an axial nerve-fibre. The external surface of the latter contains nerve-fibres, breaking up externally into fibrillæ continuous with those from the axial nerve, and forming a network or retinidium, usually supported by a cuticular secretion or rod. The pigmented cells round the retinophora may also exhibit retia terminalia in a cuticular secretion.

The visual organs of Molluscs are referable to four types; the diffuse, the invaginate, the facetted, and the pseudo-lenticulate, representing the three modifications of light-sensitive surfaces, i. e. a retineum, an ommateum, and a retina. (An ingenious comparison is made between the chromatophores of Cephalopoda and the isolated ommatidia.) The relation of these four types is shown, the invaginate have originated from the pigmented pits, and the facetted from the invaginate form. The frequent presence of an unnecessary number of eyes is explained by the hypothesis that eyes originated from organs having other functions, viz. from organs for the absorption of energy from the sunlight, or *heliophags.*

The high epithelial cells of Molluscs end at the base in several root-fibres attached to the basal membrane, and are frequently pigmented externally and capped by a double cuticula. In nearly all nerve-fibres extend along the wall of the cells towards their outer ends. A rete terminale is present throughout the whole hypodermis, and especially well developed near the eyes. In some cases large unbranching nerve-fibres pass directly to the cuticle, and seem to end in sense-hairs. These large fibres expand below the basal membrane into nucleated bipolar vesicles. This basal expansion wanders into the underlying tissue, while the outer end becomes educed to fibre, but still terminates into one or more sense-hairs. The outer end gives rise to minute cross fibrillæ which unite with others, the tuft of hairs disappears, and *the sense-cell has become a bipolar ganglionic*

* *Infra*, p. 82.

one. The body gives off secondary fibres which unite with those from other cells, and the bipolar becomes a multipolar cell. "In no case do nerves from the central system unite directly with the sense-cells. All the nerve-endings in the hypodermis mark approximately the places where the ganglionic cells originated. The latter alone are directly united on the one hand with the hypodermis, and on the other with the central nervous system. The nerves must thus terminate between cells, and probably extend to their very outer ends." Sense-cells occur, however, apparently terminating in a single fibre, which does not extend along the walls. In this connection Patten notes that while the ordinary epithelial cells which by their root-fibres form the basal membrane, probably homologous with myo-epithelial cells of Cœlenterates, the sense-hair cells, which terminate in a single fibre, are homologous with the neuro-epithelial cells. The inward prolongations of the sense-cells in the Mollusca are not then nerve-fibres, arising either from the nervous system or from peripheral ganglionic cells, but are simply nervous prolongations of the sense-cells themselves, and are probably united at their inner ends with a contractile one which originated near the sense-cell, and which during its inward growth has drawn the nervous fibre of the latter after it. The sense-cells have inter-cellular nerve-fibres like the ordinary epithelial cells. The central nervous system arose like the peripheral ganglion cells. As the ganglion cells of a single sense-organ became connected, similarly do the ganglia of remote sense-organs become connected with the central system. In the origin of a sense-organ from a group of hypodermic cells, the increase of nerve-cells is associated with increasing sensitiveness, and finally gives rise to a subjacent layer of ganglion-cells united on the one hand with the central nervous system, and the other with the sensitive cells, between which the ganglionic ones have arisen. We find abundant transitions between sensory and ganglionic cells.

"Liver" of Mollusca.*—In this communication on the so-called liver of the Mollusca Dr. J. Frenzel reports that he has made a histological examination of a number of species; in the Cephalopoda, and probably also in some Prosobranchiata, there is only one kind of epithelial cell, which is comparable to the club-shaped ferment-cells of other molluscs; in these forms the "liver" must be regarded as a digestive gland. In a number of Prosobranchiata the epithelial cells are of the granular character, and here, on Barfurth's showing, the organ must be considered to be a true liver. In the Opisthobranchiata the gland has two kinds of secreting elements, and may, therefore, be a "hepatopancreas."

As, notwithstanding all their differences, the livers of Mollusca have so many histological details in common, the author thinks the organ must have a common function; the suggestion of Barfurth that it gives rise to glycogen seems to be disposed of by the answer that glycogen is especially found in young, developing cells, and that such cells are always to be found in abundance in the molluscan liver. It is well to retain for the organ the name of midgut gland.

Nervous System of Gastropoda.†—Prof. H. de Lacaze-Duthiers points out that in studying the nervous system of Mollusca we ought to seek to recognize the primary so as to distinguish them from the secondary ganglia. This may be illustrated by the innervation of the digestive tube of some of the Gastropoda. Here the origin of the cerebrosympathetic connectives

* Boll. Soc. Adriat. Sci. Nat. Trieste, ix. (1886) pp. 226–39.
† Comptes Rendus, ciii. (1886) pp. 583–7.

on the anterior and superior face of the cerebral ganglia, and the presence of two always symmetrical ganglia at the angle made between the œsophagus and the lingual pouch are constant phenomena; these two ganglia form the stomatogastric centre, and give off a definite system of nerves. When the masticatory apparatus is robust and is moved by powerful muscles a series of small ganglionic centres make their appearance. The author describes the different arrangements which obtain in various gastropods, in which parts of the digestive tract are specially modified, and he points out that the corresponding modifications in the nervous supply must not be thought to in any way modify the interpretation of the stomatogastric centre, which always remains the same in its central part, and is only modified in a part of its periphery to respond to new wants.

Development of Genital Apparatus of Stylommatophorous Pulmonata.*—Dr. J. Brock finds the first rudiment of the generative organs of Stylommatophorous Pulmonata in larvæ just previous to extrusion; at the side of the right central ganglion, in a shallow depression, there lay directly beneath the cutis a fine cord of cells with a distinct lumen; posteriorly, the duct took a somewhat upward direction, and lay by the outer lower angle of the central ganglia. The wall of this primary genital duct consists of a layer of radially arranged cubical cells. It is to be noted that it is to be found on the right side only. This appears to be the structure which Rouzeaud calls the "bourgeon primitif," but Brock knows of no fact which would justify an ascription to it of an ectodermal origin.

The next stage studied was found in free forms, about 2 mm. long; the primary duct is longer, and the hermaphrodite gland is beginning to be formed; the first rudiment of the penis is found in a spindle-shaped outgrowth, while a thickening of the median wall is the earliest indication of the dart-sac; the hermaphrodite duct is also beginning to be formed. The author thinks the evidence that in the Pulmonata, at any rate, the whole of the generative apparatus is derived from the mesoblast, is complete.

In somewhat older animals the genital duct and the hermaphrodite gland become connected by the hermaphrodite duct, the whole of this appearing at almost the same time; it is important to note that in the Pulmonata the germ-gland and the efferent duct were primitively separate. The other changes that occur in this stage are increase in length of the duct and of the rudimentary penis; the outgrowing of the penis results in the appearance of the distally placed genital atrium. In specimens hardly any older the penial swelling becomes constricted off from the primary genital duct as a blind sac, and the hermaphrodite gland begins to be broken up into lobules. The constriction of the penis goes on rapidly, and the organ becomes greatly increased in size.

In animals 4–5 mm. long three important changes take place; these are the development of the vas deferens as an outgrowth of the penial blind sac, the division of the primary genital duct into a male and a female duct, and the breaking through of the outer genital orifice; there is no evidence at all to support the supposition that an ectodermal invagination takes any part in the formation of this orifice. The penis is now completely constricted off from the primary genital cord, and the atrium also becomes distinct. The hermaphrodite gland becomes more lobulated, and elements are developed in it which may be regarded as primitive ova; these are large rounded cells with a large round nucleus and a large nucleolus.

* Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 333–95 (4 pls.).

The next set of changes, which occur in animals 7–9 mm. long, give the generative organs their definite form; the primary duct continues to divide into two, and is continued distally into the penis, so that now the male and female ducts arise directly from the cavity of the penis. The small outgrowth at the base of the penis, in which may be recognized the rudiment of the vas deferens, increases in height, against the side of the female duct, into which it opens when the walls at the point of junction become absorbed. The flagellum appears as a blind diverticulum which arises at the base of the penis; at its blind end two secondary cæcal vesicles early become apparent. The prostate glands are developed as small outgrowths of the female duct proximal to the connection with the vas deferens. The rudiment of the receptaculum seminis was first seen in an animal about 12 mm. long, where it appeared as a short wide-necked outgrowth of the penis; it arises just below the orifice of the atrium.

We may note the following general considerations as results of this investigation; the portion of the duct which is temporarily separated off alone appears to be the homologue of the male ducts of the most closely allied forms in which there are separate efferent ducts; the single genital orifice is the homologue of the female orifice of the Basommatophora, while the male orifice is only a secondary product of the penis; the seminal groove and the prostate glands of the Stylommatophora are a product of the female duct; the anatomical relations of the ducts of the Stylommatophora must not be derived from that of the Basommatophora by supposing that there has been a secondary fusion of the two ducts. The generative apparatus of the Basommatophora may be derived from that of the Stylommatophora, but the converse proposition is not permissible. There can be no doubt that the penis and vas deferens are neomorphs, developed within the limits of the phylum of the Pulmonata.

When we extend our survey to another group of Gastropod Molluscs, we find we are justified in saying that the permanent disposition of the generative organs of the Prosobranchiata is temporary in the Pulmonata. The latter are laid down and developed on the female type, and only become hermaphrodite by the late appearance of modifications, which are, developmentally, unessential; when purely female forms are seen we must not explain the phenomenon by regarding it as atavistic, but simply as a more forcible marking of the female type which is normally predominant in development. The author reminds us that, in an earlier study, he showed that the generative organs of the least constantly or inconstantly hermaphrodite bony fishes are formed on the female type. The male genital duct is not a permanent structure, but disappears towards the end of development without leaving a sign of its presence.

The author concludes with a few notes on the anatomy and development of other systems of organs. The structural relations of the secreting cells of the foot-gland are of interest, as there are in the adult three different forms of cells. The epithelium of the basal portion forms two ciliated ridges, and is sharply marked off from the pavement epithelium of the side walls. At the base of the groove the sensory cells, as Sochaczewer called them, are situated; Dr. Brock demurs, however, to this view of their function, and thinks that they are nothing more than ordinary cells between which the glandular cells open into the efferent duct, and which are specially modified thereto. On the roof the cylindrical cells are low and devoid of cilia; they are specially remarkable for the longitudinal striation of their protoplasm. The glandular cells are generally arranged in two chief masses on either side of the efferent duct; they are not so arranged as to form compact masses, but only five or six cells form a connected

group; they are open at the base of the ciliated grooves, and a few open in the intercellular spaces of the roof of the duct, or a few unicellular glands in the groove on the lateral margin of the foot.

With regard to the calcareous cells of the liver, Dr. Brock remarks that they were present in the earliest stages of development studied by him; he asserts, as against Leydig, that the foot is continuously ciliated, and he draws attention to the little known fact that the right edge of the margin of the mantle, in the region of the respiratory cleft, is also ciliated.

Nervous System of Ctenobranch Molluscs.*—M. E. L. Bouvier finds that the proboscidial commissure which is found in scutibranch prosobranchiate Gastropods disappears from the ctenobranchiate group; but there is another connective which is very characteristic; it is that which more or less distinctly connects the right commissural ganglion with the subintestinal. This connective results from the anastomosis of the right pallial nerves which issue from the right commissural and from the subintestinal ganglia. The author enumerates various forms in which this arrangement is found. In the Cerithiidæ the conversion of the anastomosis into a connective may be studied step by step. When once formed, it varies very greatly in dimensions.

On the left-hand side the pallial nerve always retains its origin in the commissural ganglion, except in *Ampullaria*, when it is converted into a connective, going from the left commissural to the supra-intestinal ganglion.

Strength of Snails.†—Mr. E. Sandford has found that a snail weighing 1/4 oz. could drag up vertically a load of $2\frac{1}{4}$ oz. Another snail, 1/3 oz. in weight, could carry horizontally a weight of 17 oz.

Histological Peculiarities of Lamellibranchs.‡—M. L. Roule finds that the blood-channels of Lamellibranchs do not (except in the heart and pericardium) present the histological characters of closed vessels—that is, proper muscular and connective-tissue walls which can be isolated from the surrounding tissues. The canals are simple lacunæ united into a diffused plexus, with the exception of a few which ordinarily communicate between the heart and the organs. These last, which are generally known as arteries, have not really a structure different from that of other lacunæ. Numerous muscular fibres do, indeed, surround their cavities, but they are not proper to them. The connective layer which directly limits the cavity does not differ from that which is situated more deeply, and does not form a special membrane. Just like that of Tunicates, the whole circulatory apparatus of Lamellibranchs recalls the lymphatic system of Vertebrates, and the globules completely answer to those of the lymph.

A state of complete extension is habitual for the turgescent organs of individuals placed under normal conditions of environment; and contraction is a temporary stage, followed by a return to the ordinary condition. In all the turgescent organs the muscular bundles are numerous, and are set in the direction of the retraction and extension of the organs. The siphons and the edge of the mantle are not, any more than the foot, provided with pores, which serve as organs of exit for the blood during contraction or for the admission of water during extension. The mass of blood is of itself sufficient to explain all the variations of volume, according as it is transported from one region to another.

* Comptes Rendus, ciii. (1886) pp. 938–9.
† Zoologist, x. (1886) p. 491.
‡ Comptes Rendus, ciii. (1886) pp. 936–8.

Deep-sea Mollusca.*—In his report on the Brachiopoda and Pelecypoda collected in the Gulf of Mexico and in the Caribbean Sea, Mr. W. H. Dall has an interesting introduction on the deep-sea forms. Large shells appear to be rare at great depths, and when found are very fragile; the tissues are loose and gelatinous, owing probably to the necessity of affording that thorough permeation of the tissues which is necessary to equalize pressure. Almost all the shells are extremely thin and light. The colours are faint or delicate, the iridescence often peculiarly brilliant. Many abyssal shells have a delicate and sometimes profuse sculpture.

Mr. Dall points out that the word "deep" has had many significations; the abyssal area is that in which the temperature of the bottom is known to be quite uniformly cold, where the food cannot vary much in quality or quantity, and where the distribution of life is comparatively sparse and uniform; he applies the term of archibenthal area to the continental region of Prof. A. Agassiz; it is that which lies between the littoral and the abyssal. It is in this that the chief treasures of the dredger are to be found; the littoral and archibenthal faunæ are often entirely or almost entirely dissimilar, but in the far north or in the tropics the species may be found in shallow water of the appropriate temperatures.

The bottom of the ocean is generally composed of fine impalpable mud, and there are no stones or rugose inorganic objects for sedentary molluscs to perch on; the tubes of hydroids and annelids or the long spines of sea-urchins may afford the necessary *points d'appui.*

The author urges that naturalists do not seem to have realized that natural selection "may act, in certain cases, as successfully by confining the inflexibility of a particular stock, as it does in others by seizing the favourable variations of the vast majority of living beings, which vary indefinitely in all directions." It is probable that the few molluscs which have been recognized as having a world-wide distribution owe their uniformity to some such cause as this. The abyssal molluscs are nearly all flesh-eaters, and as they get their food from the constant gentle rain of dead or dying animals, they are not compelled to prey much upon one another.

As it seems to be a general law of animal structures that the greater the number of similar parts in any member of an organic individual, or of similar members, the greater the tendency to vary, first in the minor features of these parts as compared with each other, and secondly in the number of similar parts in any individual as compared with the average number characteristic of the species; and as in the deep sea the factors which affect the tendencies to vary—absence of light, of enemies that can see, of violent motion—are almost eliminated, "the logical result is that we may expect in the deep sea a very wide range of variation in form and sculpture within the specific limits of the 'flexible' species, and an almost complete uniformity over very wide areas of the forms which we may consider as inflexible species." And this, in Mr. Dall's judgment, is what is actually found.

Of the groups of Mollusca described in this report there are 227 species or varieties, 81 of which are new; there are 12 new subgenera or sections.

* Bull. Mus. Comp. Zool. Cambridge, xii. (1886) pp. 171–318 (9 pls.).

Molluscoida.

α. Tunicata.

Morphology of Tunicata.*—MM. E. van Beneden and C. Julin have continued their researches on the morphology of Tunicates. After an historical review of the state of opinion in regard to some of the main morphological problems, the authors proceed to give a detailed account of the embryonic development of *Clavellina Rissoana*.

I. The chief conclusions of the first chapter are as follows:—(1) The first segmentation plane corresponds to the median plane of the gastrula. The entire right half of the body arises from the right blastomere. The median organs, such as medullary tube and notochord, arise from a double rudiment, forming two identical portions, separated by the median plane. In the earliest stages no cells are exactly median. Afterwards, however, this is not so, and some cells may pass from one side to the other. (2) The second plane is transversal, dividing each blastomere into anterior and posterior portions; the third is horizontal. (3) The formation of the ectoderm results from successive protrusions from mixed or undifferentiated elements. After 32 are thus formed the process stops, the endoderm is formed, and the invagination begins. (4) The last ectoderm cells formed as above are always disposed at the periphery of the anterior ectodermic plate, and since the margin of this plate forms the rudiment of the nervous system, it may be affirmed that the cells forming the epidermis are formed before those which give rise to the nervous system. (5) At the 8 stage the tubular and vertical segmentation cavity opens to the exterior at each end; at the 16 stage it is closed, and with the formation of 32 cells it disappears. It has therefore no genetic connection with spaces subsequently occupied by the mesenchyme. (6) When gastrulation begins, the medullary cells which form the outline of the nervous system, are readily distinguishable. They form a ring immediately surrounding the blastopore, and markedly larger in front, than on the side of, or behind, the latter. (7) At the same stage the common outline of notochord and mesoderm is seen to be separated from the rest of the endoderm which forms the gut. The former also appears as a ring round the blastopore. (8) An important portion of the medullary plate lies behind the blastopore, forming part of its posterior lip and contributing to form the arch of the medullary tube. Kowalewsky's results are here confirmed. The process of closure is throughout essentially the same. (9) At no position or stage of development is the medullary plate separated from the epidermis to form the floor of a canal, of which the roof is formed from the epidermis. (10) The nervous system primitively consists of two exactly similar portions, but these come to be intimately connected, and to take up in part a median position. (11) The notochord developes at the expense of the primitive endoderm below the median and problastoporic portion of the medullary plate. It arises in front of the blastopore at the expense of a portion of the rudiment which also forms the mesoderm. It arises as a furrow and forms a cord by the progressive approximation of the margins. It only becomes secondarily median. (12) The mesoderm developes at the expense of the endoderm, in the form of two lateral portions separated dorsally by the notochord, and ventrally by the gut-forming endoderm. An anterior portion is resolved into mesenchyme, the posterior region forms the caudal muscles. The first portion arises in enterocœlous fashion in the form of lateral diverticula from the archenteron. The second portion arises similarly, but this pos-

* Arch. de Biol., vi. (1885) pp. 237–476 (9 pls.).

terior portion is directly transformed into muscular cells. Though the segmentation of the tail is not apparent, it is none the less real. (13) The alimentary canal of the larva is straight and median. It is continued by a neurenteric canal into the medullary tube; but both this and the caudal portion of the intestine disappear. The remainder includes three distinct portions: (*a*) the precordal dilatation, (*b*) a shrunk region, of gutter-like form, open above, and roofed by the notochordal plate, (*c*) a long rudimentary portion, without cavity, lying beneath the notochord as a double row of endodermic cells.

II. *The heart, the pericardium, and the epicardiac tube.*—The open tubular heart has a delicate muscular wall, connected along one line, by a suture or raphe, with the pericardiac epithelium round about. The cardiac cavity arises as an invagination of a portion of the pericardiac wall. They thus really form one sac. The heart is but the visceral layer of the pericardium. If it were not for the absence of a vascular endothelium the ascidian heart would be directly comparable to that of a vertebrate embryo. The epicardium associated with the heart forms a blind tube, forked in front, and opening by two distinct orifices, right and left, into the branchial cavity between the entrance to the œsophagus and the posterior extremity of the hypobranchial groove. The cavities are lined by an epithelium continuous with that of the branchial sac, at the level of the orifices. The whole arrangement is intimately described. The epicardium separates the two principal currents of blood—the postero-anterior, ventral, hypobranchial, or sub-epicardial, from the antero-posterior, aortic, or supra-epicardiac current. The epicardium and pericardium, which are thus physiologically and anatomically associated, arise genetically from the same embryonic formation—the procardium. From the development of this procardium, which is discussed in detail, it is evident that heart, pericardium, and epicardium all develope at the expense of the branchial endoderm. It is further noteworthy that the procardium arises from a double rudiment, and that the right portion is smaller than the left.

In the bud the internal vesicle results from the separation of the two cellular layers adjacent to the stolon partition. The elongated vesicle is divided transversely into terminal and basilar portions, of which the former gives rise to branchial sac and epicardial tube, and to secondary diverticula, the peribranchial cavities and digestive tube. The basilar portion forms the pericardial sac, of which the invaginated roof becomes the wall of the heart. The subsequent changes are described at length, and the authors show that the mode of development, and anatomical relations of the cardiac organs, are different in the forms arising from a urodelous larva, from what they are in those arising from buds. The heart of the adult is then described.

III. The third chapter contains an account of the development of the alimentary tract. The three regions of the larval tract have been noted above. That of the adult arises wholly from the two first portions of the larval mesenteron. The authors' observations show that the branchial sac, the œsophagus, and the stomach are differentiated portions of the one primitive larval rudiment. These three portions have remained median and symmetrical. The stomach ending in a cul-de-sac is prolonged backwards in a short stout cellular cord, the remnant of the caudal portion of the primitive mesenteron. The intestine arises in the form of a secondary diverticulum from the floor of the stomach. It is a new and superadded structure. Its mode of development recalls that of glands. The intestinal cæcum arises to the right at the level of the anterior extremity of the notochord. It originates rather from the precordal, than from the subcordal

portion of the primitive mesenteron. It is certain that the anus does not represent the posterior extremity of the second portion of the mesenteron. It is necessary to distinguish clearly between the descending portion of the tract developing out of the primary rudiment, and the ascending portion arising as secondary cæcum from the floor of the stomach. In every way the adult *Clavellina* is seen to be absolutely like the visceral portion of the larval trunk, extended lengthwise after the atrophy of the tail.

IV. *The reproductive system.*—In this chapter the development of the reproductive organs is described in *Perophora*, *Clavellina*, and *Phallusia*. The genital rudiment is of mesodermic origin, and appears in the concavity of the intestinal curve. The same rudiment forms testis, ovary, and ducts. There is no distinct ovarian rudiment, nor are there two cellular cords, but always only one. The female organ of a *Perophora* or *Clavellina* is simply an embryonic vesicle considerably elongated, in which the epithelial wall forms in certain regions ovarian follicles. A secondary diverticulum arising from the floor of the primitive vesicle is the first rudiment of a testis. The various stages are described in detail.

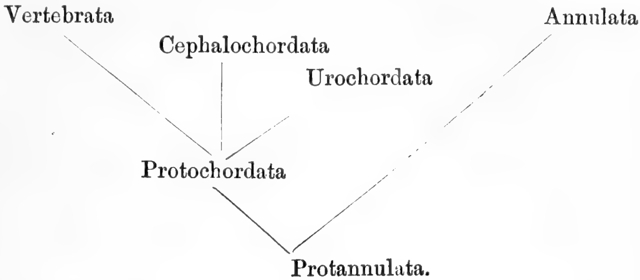
As to *oogenesis*, Kowalevsky's early conclusions are confirmed. The egg-envelope appears after the follicular cells have disposed themselves in two layers. It is therefore of epithelial origin and separates the primitive epithelium into two portions,—the test-layer, and the secondary follicular epithelium. A subsequent subdivision of this external layer, about the time of egg-laying, results in the formation of two layers—one adjacent to the egg-membrane and homologous to the papillary or spumose layer of other Ascidians, the other opposed to the "anhyste" membrane described by Fol in *Ciona* as the membranous follicular layer. The primitive follicular epithelium formed by a simple layer of flat cells is derived from follicular cells interposed between the primordial ovules in the germinal epithelium. This epithelium gives rise to two "membranes anhystes," and to three cellular layers, viz. from the outside inwards—(1) the membrane anhyste of the follicle, (2) the membranous follicular layer, (3) the papillary or spumose layer, not so in *Clavellina*, (4) the "membrane anhyste" of the egg-envelope (Fol's chorion), (5) the testa layer. Of these 1 and 2 remain till the egg is laid; 3, 4, and 5 are expelled along with the egg. The latter is naked and gives rise to no membrane. The envelopes which surround it after, as before laying, are of follicular origin.

V. The fifth chapter discusses the *longitudinal muscles.* In their structure they rather resemble the primitive bundles of vertebrate muscle than the cellular fibres; there is, however, no cross striping.

The remaining hundred pages are occupied with the discussion of general morphological questions raised by the above investigation. The development of *Clavellina* is very intimately compared with that of *Amphioxus*, the question of the vertebration of the larvæ is fully discussed, the morphology of the heart, branchial slits, and various cavities is critically resumed, and the interpretation of Tunicata as degenerate fish is unfavourably criticized.

As to the systematic position of Tunicata, the authors conclude their valuable memoir as follows:—(1) The Tunicata, Cephalochordata, and Vertebrata form a single group—Chordata. (2) The Tunicata have, like the other two divisions, arisen from segmented enterocœlous organisms, like the Archiannelid worms. Animals like Protodrili, but with dorsal chord and anterior respiratory diverticula from the gut, formed the common starting-point for the Chordata. In these Protochordata the posterior portion of the trunk is adapted more especially for locomotion, while the

caudal region of the ancestral digestive tube has undergone progressive atrophy, and the vegetative functions have become more localized in the anterior part of the trunk. This transformation of one part of the segmented body of the vermiform ancestors has affected all the trunk, except the cephalic extremity and first segment of the body, in those forms whence the Urochordata have arisen. (3) The affinities between Uro- and Cephalochordata are much closer than between either and the Vertebrata. This graphic representation is suggested—



Anatomy of Amaræcium torquatum.*—M. C. Maurice gives an account of the heart, alimentary canal, and reproductive organs of the compound Ascidian *Amaræcium torquatum*. A cross section through the middle of the post-abdominal region reveals three cavities, of which the median is shown to consist of an organ (epicardium) depending from the branchial cavity, while the two others are prolongations of the pericardium. The cardiac cavity is open, not only at both ends, but all along. The cleft is situated on the convex face of the crescent formed by the heart, turned from the epicardial sac, which cannot therefore close it. The cells of the cardiac epithelium exhibit on the side of the heart-cavity a layer of muscle-fibrils; the nuclei on the other hand are situated towards the pericardial cavity. Neither heart nor vessels exhibit endothelium.

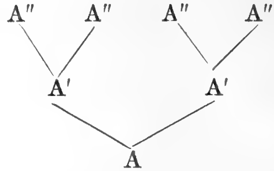
The tubular gland along the intestine is well marked. It consists of many small tubes ending in culs-de-sac, and with a common canal conducting the secretion into the stomach. The anus has a large mouth and several sphincter muscles. The cloacal cavity forms in the reproductive period an incubatory chamber. In this the oviduct also shares. The cloacal orifice bears a series of epithelial languettes.

The reproductive organs are in the post-abdomen on the dorsal side. The ovary is in front of the testis. The oviduct is well defined, attached to the outer surface of the vas deferens. It is flattened, and lined by non-ciliated epithelium, while the vas deferens is round and ciliated. The ovarian cavity is continuous with the oviducal. The flat epithelium becomes at certain points germinal, forming the follicles, from which the mature ova drop off into the cavity. The ovary and testes are never functional at the same time.

Blastogenesis of Botrylloides rubrum.†—M. S. Jourdain disputes the accuracy of some of M. Giard's results with regard to the blastogenesis of this Ascidian, and contends that blastogenesis, with the substitution of bud for parent, is not confined to the postlarval life; it is continuous, that is to say, it happens during the whole life of the stock, and is only accelerated

* Comptes Rendus, ciii. (1886) pp. 504–6. See also this Journal, 1886, p. 955.
† Comptes Rendus, ciii. (1886) pp. 1086–8.

in the postlarval period. Moreover, this blastogenesis is centripetal, the new individuals appearing outside the cycle already in activity. An arrangement which frequently obtains may be indicated by the following diagram:—



It is interesting to note that the buds, to whatever stage they belong, are at first hermaphrodite; in the cold season both glands atrophy as the bud grows; later on, the male gonad alone persists; in warm weather both kinds of gonads are completely developed.

β. Polyzoa.

Phylogeny and Ontogeny of the Polyzoa.* — Herr K. Kräpelin communicates some of the results of a prolonged study of the fresh-water Polyzoa of Germany.

I. *Phylogeny.*—The Phylactolæmata are derived from the Ctenostomata, and especially from forms like *Arachnidium* and *Victorella*, which possess creeping processes with knotted swellings. From these the Paludicellæ first develope with hibernacula or winter buds, comparable to the tuberculate swellings of the former. The hibernacula are true buds, with embryos containing ecto- and endoderm, and represent the statoblasts of the Phylactolæmata and especially those of *Fredericella*, which is not forked like *Paludicella* but bears at the position of the lateral branch an internal statoblast with bivalve shell. The statoblasts of *Fredericella* are borne both on the creeping and on the upright cystids. *Fredericella* is an important transitional form connecting Phylactolæmata and Ctenostomata. Further development occurs along two lines, (*a*) alteration in the consistence of the chitinous ectocyst, and (*b*) multiplication of the number of tentacles. A development of the lophophore, and increased production of statoblasts, are associated with the resulting improvement of nutritive conditions. Statoblasts with and without swimming ring appear together. With increased firmness of ectocyst vertical cystids preponderate as in *Alcyonella*, while the reverse results in hyaline creeping forms. The sessile statoblasts disappear, and spinose anchor-bearing forms with swimming rings replace them.

II. *Ontogeny.*—The *spermatozoa* arise directly from naked "endoderm" spermatides, the head forms the nucleus, and a "residual body" remains. The *ova* also result from "endoderm" cells of the cystid wall, not of the funiculus. They are surrounded by an "endoderm epithelium" and thus form an ovary of the simplest type. They are fertilized in the ovary and do not pass into the body-cavity.

The segmentation results in a mass of uniform cells. These differentiate into two groups of which one forms the embryo, while the other is apposed to the maternal embryonal envelope and degenerates. A blastula with wide central cavity is formed, and some kind of embolic process forms a "gastrula." The gastrula-cavity is the future body-cavity, and its layers

* Biol. Centralbl., vi. (1886) pp. 599-602 (Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, Berlin, 1886).

are the "ectoderm" and "endoderm" of the cystid. An invagination at the anterior pole forms the polypide. The "ectoderm" forms the intestinal epithelium, and from it the ganglion is separated off. The alimentary canal is a simple invagination of the cystid wall. An upward curvature precedes the rupture into the tentacle disc, and with this is associated the formation of three dorsal invaginations, into the cavity of the two-layered polypide-bud. Of these the two lateral form the lophophore, while a median represents the sharp twist of the hind-gut towards the œsophagus.

Herr Kräpelin would regard the hypoblast of the gastrula as mesoderm. The archenteron is thus an enterocœl, and the intestinal epithelium of the polypide-bud is the true endoderm arisen by gastrulation. The theory of the double character of the Polyzoon (cystid and polypide) is thus gratuitous, and the Polyzoa form a welcome connecting link between Cœlenterata and Enterocœlia.

The ciliated embryo leaves the maternal body-cavity through a "prolapsus uteri" in the dead polypide. He confirms Nitsche's account of the development of statoblasts. They too arise from *both* layers of the funiculus. One portion of the "ectoderm" forms the chitinous shell, while the other developes directly into the outer layer of the body-wall of the statoblast embryo. The development of the sessile statoblasts is essentially similar to that of the free forms with the ring of air-cells.

Blastogenesis in the Bryozoa.*—M. A. A. Ostroumoff has some remarks on M. L. Joliet's recent paper on blastogenesis in the Bryozoa; the "rudiment of the digestive canal" is, M. Ostroumoff thinks, nothing more than a mass of lymphatic cells; on this subject reference is made to Kükenthal's observations on the lymphoid cells of Annelids. The figures of Nitsche are defended against Joliet's criticisms.

Life-history of Pedicellina.†—Mr. S. F. Harmer, from a personal study of the metamorphosis of *Pedicellina*, has been led to confirm Barrois' account, and to withdraw his previous opinion; he now concludes that the postlarval changes consist in a remarkable metamorphosis, and that the first bud is formed after the primary individual has acquired its adult characters. The author thinks that the metamorphosis of *Pedicellina* is a simple modification of a more archaic process, due to abbreviation of development, that the oral groove persists partly as the adult lophophore, and that the vestibule closes at fixation and undergoes the whole of its alterations in the interior of the larva; a secondary opening is effected when the adult condition is practically attained.

It is probable that the growing point of a stolon of *Pedicellina* consists solely of an ectodermic layer secreting a cuticle, and a mass of indifferent connective-tissue cells, imbedded in a structureless jelly. With regard to the so-called brown bodies of the Ectoprocta, Mr. Harmer cannot doubt but that they are degenerated polypides; in *Pedicellina* degeneration is too slight to give rise to a characteristic brown body.

Recent Marine Polyzoa.‡—Mr. G. R. Vine has drawn up for the British Association a report on recent Cheilostomatous and Cyclostomatous Polyzoa, in continuation of his reports on the fossil forms; especial attention is given to the recent works of Mr. Busk and the Rev. T. Hincks, and their terminology is explained. The present notice deals more with the home of than with the animal itself; for the study of the latter the author

* Zool. Anzeig., ix. (1886) pp. 618–9.
† Quart. Journ. Micr. Sci., xxvii. (1886) pp. 239–63 (2 pls.).
‡ Report. Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 481–680.

recommends the mastery of the details furnished by Barrois on their development, and a study of mounted or living specimens of *Carbasea* for the Cheilostomata, of *Zoobotryon pellucidus* for the Ctenostomata, and *Crisia foliacea* for the Cyclostomata. After a tabular list of families and an index of names, the author enters on the systematic arrangement of the genera and species; the synonymy is here given, and there is an elaborate list of synonyms given in index form. These are followed by tables of geographical and bathymetrical distribution arranged by authors—a not very convenient arrangement. The whole concludes with a bibliography.

Polyzoa of the Black Sea.*—M. A. A. Ostroumoff communicates a lengthy memoir on the Polyzoa of the Gulf of Sebastopol. He distinguishes 11 species, 6 in the zone of the Ulvas and Zosteras, 5 in the zone of Phyllophoreæ.

I. In his general introduction the nomenclature and general features are discussed; he distinguishes the calcareous *Cheilostomata* from the chitinous *Ctenostomata*. In the former the typical zoœcium is a tetragonal box. Of the two transverse faces, that with the orifice is termed "opercular" or "pallial," and that by means of which the colony is fixed—"basal." The orifice does not always open in the centre of the opercular face, but near one of the sides, which he terms "distal" or superior, while the opposite one is termed "proximal" or inferior. The *Cheilostomata* have a semicircular operculum; the *Ctenostomata* have none. The modifications in various subdivisions are briefly noted. Among ovicells the author distinguishes (1) those forming an integral part of the colony, with the whole zoœcium (except the digestive tube) subordinated to containing the ova formed at the expense of the nearest complete zoœcia; and (2) those acting rather as organs, and occurring on certain zoœcia only during sexual maturity. The *Cheilostomata* are covered with spicules, which probably increase the respiratory surface. The skeleton of the zoœcium exhibits pores on the basilar surface, opening communication between mother and daughter zoœcium, or on the lateral surface connecting adjacent zoœcia, or thirdly, on the opercular face communicating directly with the exterior. Nine species are then diagnosed at some length.

II. *Anatomical results.* (*a*) *Derivatives of the ectoderm.*—On the polyzoon larva or young bud a delicate ectoderm is readily detected below the cuticle. This soon exhibits a sort of cellular separation; the nuclei go apart; the protoplasm gathers round them and forms irregular prolongations, and a reticulated appearance results. The great difficulty of perfect fixing has led to varied descriptions by different observers. The skeletal development is then described, and the means taken to secure efficient respiration are noted. Internally the ectoderm gives origin to the epithelial membrane of the tentacular sheath, to the stomodæum, proctodæum, superior cells of the tentacles, and nervous ganglion. These are then discussed in order.

(*b*) *Derivatives of the endoderm.*—The median portion of the alimentary canal, viz. the stomach, with its ciliated pyloric portion and cæcal appendage, are of endodermic origin. The stomach proper lies between the cardiac thickening and the pyloric chamber. With the endoderm there is further associated the "brown mass," which has been so variously interpreted as ovary, embryonal capsule, &c. It is doubtless a stomachic cæcum in which the ordinary secreting function of the cells has been replaced by that of assimilating the products of cellular degeneration. The brown mass includes not only the cæcum and detritus, but a button-like mass of

* Arch. Slav. de Biol., i. (1886) pp. 557-69 (5 pls.); ii. (1886) pp. 8-25, 184-90.

cells, which become attached to the ectodermic portion of the alimentary canal to form the median or endodermic region.

(*c*) *Derivatives of the mesoderm.*—In the marine Polyzoa the general cavity is not lined by a mesodermic epithelium. The walls of the zoœcium only exhibit a single sub-skeletal layer of ectodermic cells. Scattered mesoderm cells occur near the wall, attached on the one hand to the ectoderm, and internally to other cells forming a funiculus. These mesoderm cells are better described as funicular than as parenchymal tissue. The muscular system is described in detail. Those of the digestive tube or polypide are to be distinguished from the parietal and opercular muscles of the zoœcium. Histologically there are three groups: (*a*) muscles composed of isolated filiform fibres, with undifferentiated contractile substance, covered by a delicate sarcolemma, best seen near the spherical nucleus, which lies near the middle of the fibre; (*b*) muscles in which the extremities enlarge at the punctum fixum into a long triangular band; (*c*) muscles of the principal retractor, transversely striated, but only peripherally, so that the central substance remains undifferentiated. The reproductive organs are also mesodermic. The products fall into the cavity of the zoœcium, and thence into the tentacular sheath, which ruptures in admitting them.

(*d*) *Development.*—Herr Ostroumoff finally distinguishes and describes three types of larvæ:—(*a*) the ordinary type of Chilostomata, (*b*) the Cyphonaut type, (*c*) the vesicularid larva or Ctenostoma type. A brief notice of the metamorphosis (generally corroboratory of Barrois) concludes all that has yet been published of this memoir.

Arthropoda.

Spermatogenesis of Arthropods.*—Herr H. de Wielowieyski reports some of the results of his researches on Arthropod spermatogenesis, which were independent of the investigations of Prof. Gilson, though mainly corroborating his conclusions.

1. Contrary to the opinion of several observers of vertebrate spermatogenesis, Wielowieyski maintains that the chromatic nuclear filament of the spermatocyte is not directly formed into the head of the spermatozoon, but breaks up, becoming thoroughly distributed among the achromatic plasma.

2. While Gilson explains the multinuclear spermatogonia as the result of endogenous division, Wielowieyski maintains that they arise by the very complete fusion of individual cells.

3. In *Asellus aquaticus* Gilson notes how the mother sperm-cell divides into two, of which the one portion continues to divide into spermatocyte nuclei embedded in the common protoplasm, while the outer half (which he calls female) remains passive and undivided, finally, however, disintegrating. This suggestive history is denied in toto by Wielowieyski, who maintains that here also the mother sperm-cell divides into separate spermatocytes. The appearance Gilson described, he regards as due to artificial confluence.

4. In insects, Gilson described the developing spermatozoa plunged in the remnant of the protoplasm of the spermatogonium, with one or more (female) nuclei in the wall. The envelope round such a bundle appeared to Wielowieyski, on the other hand, distinctly cellular, in fact an epithelium.

5. In conclusion he notes the presence of accessory cells occurring

* Arch. Slav. de Biol., ii. (1886) pp. 28–36.

among the sperms in the ejaculatory tubes of *Melolontha vulgaris*, and apparently also the direct results of spermatogenesis.

Bacteriological Studies in Arthropods.*—M. E. G. Balbiani finds that saprophytic bacilli, when inoculated into the blood, are pathogenic for a large number of Arthropods. Death follows in from twelve to forty-eight hours, according to external temperature, number and origin of spores, size, age, and susceptibility of the subject. They die with all the symptoms which characterize the disease known as "flacherie" in silk-worms, a malady determined by the development of various species of bacteria in the organism. Insects of different orders are not equally susceptible; those which contain a small quantity of blood in proportion to the mass of the body (Lepidoptera, Diptera, Hymenoptera) are killed more rapidly and surely than those in which the relative proportion of blood is greater, and (above all), in which the blood is richer in corpuscles; this is specially the case with the Gryllidæ.

The resistance is due to the corpuscles seizing by their pseudopodia on the bacilli, and to the elements of the pericardial tissue, which seize on and destroy the poisonous organisms. This identity in mode of action is ascribed to the genetic relation which exists between the two kinds of cells. Death is delayed if the spores are kept for more than six years in a state of desiccation.

a. Insecta.

Spermatogenesis of Beetles.†—Prof. v. La Valette St. George adds a fourth communication to his recent studies on spermatogenesis. He now discusses that of beetles as illustrated by *Phratora vitellinæ* and a few other forms.

The general facts remain the same, the details alone vary. Primitive sperm-cells, spermatogonia, spermatocysts of spermatocytes, spermatides and spermatozoa follow one another as usual. Recent researches by Gilson and Spichardt are critically referred to. The cellular cyst-skin ("Cystenhaut") round the spermatocysts was well seen; it usually contained two nuclei. As usual, the nuclei of the spermatocytes are often divided without the protoplasm being divided and rounded off about them.

In the spermatocyte the neighbour nucleus (accessory nuclear body —"Nebenkern") appears as a simple thickening of the cytoplasm near the nucleus. It becomes associated with the nuclear contour like the stamp on a signet ring. It exhibits a threadwork structure, as is intelligible from its association with mitosis, sharing in the formation of the spindle-fibres, and representing the residue of nuclear threads after the formation of daughter nuclei. In the spermatide the neighbour nucleus retains for a while its threadwork, but sends out a fine process, the first hint of the sperm. Together with the nucleus it forms the head of the latter. Two threads in the tail were detected. It appears as if both tail and head were ensheathed in a special layer of cytoplasm, while its variable contractility presents the different appearances often described.

Oogenesis of Insects.‡—Herr F. Blochmann reports the results of his investigation of the much-discussed oogenesis of insects. His conclusions are not corroboratory of Will's statements. The young ovum has a large, but not very richly chromatic nucleus. As the ovum enlarges, vacuoles

* Comptes Rendus, ciii. (1886) pp. 952–4.
† Arch. f. Mikr. Anat., xxviii. (1886) pp. 1–13 (4 pls.).
‡ Festschrift d. Naturh.-Med. Vereins Heidelberg, 1886. Cf. Biol. Centralbl., vi. (1886) pp. 554–9.

appear close round the surface of the nucleus, and in these a small granule appears. They look like nuclei, in fact, and are termed by Blochmann "neighbour-nuclei" ("Nebenkerne"). They increase in number and the principal nucleus becomes smaller.

In the hitherto granular protoplasm a peculiar structure appears like a much-coiled bundle of threads. They consist of regular rows of rod-like bodies 10–12 μ in length, like bacteria, and multiplying by division. At an earlier stage similar bodies are seen in the epithelial cells. They are dissolved in 5 per cent. soda solution, cannot be cultivated, and are not bacteria. At the beginning of yolk-formation they retire to the posterior pole and spread out under the blastoderm. After a while they pass into cells of the embryo. They are not unlike the bacteroids developed in the tubercles on leguminose roots and known to be albuminoid bodies.

As the yolk appears the neighbour-nuclei are scattered over the surface of the ovum, where they are for long visible among the yolk spheres, eventually, however, disappearing. They have no connection with follicle-formation.

The yolk-formation occurs first in the portions next the follicular epithelium. Vesicles appear, first with granules and then with a firm network. These pass inwards, and the peripheral ovum protoplasm forms more. The so-called nutritive cells must aid in equipping the egg, but there is certainly no reception of formed yolk-particles by the egg from outside. A distinct yolk-nucleus was observed.

The germinal vesicle retains its position at the anterior end of the ovum and forms a nuclear spindle. Hints of a polar cell were detected. In three different orders of insects Blochmann demonstrated the presence of germinal vesicles, which does not agree with Stuhlmann's recent observations. In *Musca vomitoria* a polar cell was distinctly observed, and its mode of formation was normal.

In reference to the difficult problem of the relations of yolk, epithelial cells and ova in insect oogenesis, Dr. J. H. List * communicates the result of some observations on *Orthezia cataphracta*.

1. Each tubule exhibits a superior terminal yolk-chamber, and an inferior egg-chamber. The latter is lined by high cylinder epithelium, lower in the terminal chamber.

The terminal chamber exhibits at an early stage, yolk flakes formed from modified epithelial cells. Traces of the component cells are for a while visible in the form of nuclei and cell-boundaries. The nuclei degenerate, however, and are replaced by a new large nucleus. These yolk-cells break down into yolk granules and form the yolk of the ovum.

2. The ova arise from the epithelium of the egg-chamber, by a modification, perhaps budding of one, or rarely more of the lining cells. The appearance at different stages is briefly noted.

Origin and Significance of Cellular Elements of Ovary of Insects.†—Dr. E. Korschelt concludes that the various cellular elements of the ovarian tubes of insects—ova, nutrient cells, and epithelium—all arise from similar indifferent elements, which are found in the contents of the first rudiment of the tubes; the first formation of the cells and the connected differentiation of the several segments of the tube commence in the embryonic period; that is, during larval life. The indifferent elements correspond to the embryonic condition, and they in post-embryonic and even during imaginal life, continue to give rise to fresh supplies of the various kinds of cells. Different

* Biol. Centralbl., vi. (1886) pp. 485–8.
† Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 537–720 (5 pls.).

insects differ greatly in the way in which the various kinds of cells are formed from the indifferent elements. It is clear from their histological peculiarities, and from the mode of origin of their elements, that the ovarian tubes which are of complex structure and are provided with nutrient chambers, must have been derived phylogenetically from tubes without nutrient chambers. In some cases the nutrient cells are formed at the same time and in the same way as the germinal cells, and they are then to be regarded as germinal cells which have gradually lost the function of forming ova and have taken on that of producing nutrient substance.

In the ovarian tubes which have several nutrient chambers the nutrient cells may be formed at the same point as the egg-cells, and even later they may be found mixed up with them at the commencement of the tube. The tubes with a terminal nutrient chamber appear to have been formed owing to the capacity for forming ova having been handed over from the primitive germinal cells at the tip of the chamber to those which lie at its base. The nutrient cells of other forms arose independently of the germinal cells, and must not therefore be referred to them. In all forms the epithelium is developed in much the same way, and always has a great resemblance to the indifferent elements of the terminal chamber from which it directly arises; the author was never able to convince himself of the formation of epithelium from germinal vesicles, from the nuclei of nutrient cells, or from the so-called ooblasts. Neither the ova of Hemiptera or any other insect are formed of ooblasts, but arise, like the epithelial and nutrient cells, by the gradual differentiation of the indifferent elements of the ovarian tubes. All the various elements of the tube are morphologically of the value of cells.

Chemical Composition of Ova.*—Herr A. Tichomiroff has analysed the ova of *Bombyx mori*, and compared the composition before, and at the close of incubation. The shell contains a substance which he terms chorionine, containing less sulphur than keratine. The proportions of albumen and insoluble salts, of aqueous extract and glycogen, of ethereal extract, fat, lecithin, and cholesterine, of chorionine and chitin, of nitrogenous bases, are noted. Before incubation the ova contain 100 parts of liquid material and 35·5 of solid substances, while at the close of incubation the respective figures are 88·8 and 30·2. In developing, the ova therefore lose 7 per cent. of water and 3 per cent. of solid material. The loss is principally in glycogen and fat.

Law of Orientation of the Embryo in Insects.†—M. P. Hallez has continued his observations on the relations which exist between the principal axis of the mother and the organic axis of the egg, and between the organic axis of the egg and the principal axis of the embryo. The insects best adapted for such investigations are those which deposit their ova in cocoons, those which have an oviscapt, or such as have certain peculiarities, such as micropylar appendages

The first form described is *Locusta viridissima*, where it was found that the head of the embryos is always formed at the superior part of the egg, and that the convex line of the ovum corresponds to the dorsal surface of the embryo.

In *Hydrophilus piceus* the head, contrary to what obtains in most cases, looks downwards; the principal axis of the embryo has the same orienta-

* Zeitsch. f. Physiol. Chimie, ix. (1885) pp. 518–32. Cf. Arch. Slav. de Biol., ii. (1886) pp. 133–4.

† Comptes Rendus, ciii. (1886) pp. 606–8.

tion as the same axis of the mother. The author concludes with the generalization that, in insects, the egg-cell has the same orientation as the mother, has a cephalic and a caudal pole, a right and left side, and a dorsal and a ventral surface, and that these correspond to those of the embryo.

Artificial Parthenogenesis.*—Herr A. Tichomiroff has investigated the parthenogenesis of the ova of *Bombyx mori*. The really parthenogenetic reproduction is confirmed, and it is also shown that ova which would not of themselves develop parthenogenetically might be induced to do so by certain stimuli. These stimuli consisted in rubbing the unfertilized ova with a brush, or in dipping them for two minutes in concentrated sulphuric acid, and then washing them. In both cases a percentage of the stimulated ova developed, but in the unstimulated parthenogenetic lot none seemed able to do so.

Thoracic Salivary Glands homologous with Nephridia.†—As the result of some studies on the structure of lower insects (*Campodea*, *Lepisma*, *Mactilis*, &c.), Herr N. Nassonow has been led to the conclusion that a portion of the efferent ducts of the male genital organs develope from the mesoderm, and that the thoracic salivary glands of insects are homologous with the segmental organs of worms. It is further probable that the oviducts also, several accessory glands in association with the reproductive organs, and likewise the abdominal tubules of *Campodea* and *Mactilis* are remains of segmental organs.

Leydig's Cord.‡—In studying the eggs of *Blatta germanica* and some embryos of *Melloe proscarabeus*, Herr J. Nussbaum noted the presence of an organ which he regards as homologous with the notocord of vertebrates. It is, however, of mesodermic origin. The cord found by Leydig in 1862 is regarded as homologous to the external neurilemma of the nervous system plus the cellular-connective tissue of the abdominal diaphragm.

Ants and Ultra-Violet Rays.§—Whilst Sir J. Lubbock considers that ants perceive the ultra-violet rays by means of their eyes, Graber finds, by removing these organs from tritons, &c., that it is by the skin that these rays are perceived. Prof. A. Forel has made experiments in order to answer the question whether ants perceive these rays by means of their eyes, or by the skin; and he finds that it is mainly by the former organs, but admits that "photodermatic" perception may accompany the optic sense. *Camponotus ligniperdus* and *Formica fusca* served for his experiments, and a "solution d'esculine" was used for absorbing the ultra-violet rays.

Insect-skin.‖—Prof. C. S. Minot distinguishes on the cuticle of insect larvæ a very thin lamella, often markedly pigmented. The surface is usually divided into areas, each of which corresponds to a subjacent epidermal cell. The middle of each area usually projects, and the lamella covers the elevations with its pigmented sheath. The form and pigmentation of these areas vary greatly, and may be utilized for diagnostic purposes. In primitive forms like *Peripatus* and in some Orthoptera, the elevation of the thick cuticle over each cell bears a number of small points. The boundaries of the areas may disappear, and the points remain or be reduced in number. Or the elevations may remain and the points fuse together.

* Arch. f. Anat. u. Physiol. (Physiol. Abtheil.) 1886, Supplement, pp. 35–6.
† Biol. Centralbl., vi. (1886) pp. 458–62.
‡ Kosmos (Polish) 1886. Cf. Arch. Slav. de Biol., ii. (1886) p. 291.
§ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 346–50.
‖ Arch. f. Mikr. Anat., xxviii. (1886) pp. 37–48 (1 pl.).

By a further change the whole elevation is covered by an uninterrupted pigmented lamella, as in many butterflies. These pigmented elevations may be thick or sparse, hair-like or simply pointed, and so on. Some reference is made in this connection to fossil caterpillars.

Morphology of Insects' Wings.*—Herr N. Cholodkovsky commences by stating that, notwithstanding all the text-book statements to the contrary, the first ring of the thorax of Lepidoptera is in no way connected with the second. At the boundary between its notum and pleuron there is, on either side, a hollow evagination of the chitinized skin, which is, in an uninjured specimen, closely covered by hairs and scales. In position and form this outpushing is exactly like the rudiment of a wing, and it would hardly be wrong to call it the rudimentary prothoracic wing. Not only has the author observed these rudiments in various Lepidoptera of all the most important families, but Fritz Müller has seen them in some Termite-larvæ; Woodward has described a fossil (*Lithomantis carbonaria*) with two wing-like appendages to its prothorax, and Graber has discussed the matter.

The physiological significance of these appendages is very difficult to understand, but it is important to observe that there are no indications of them in the larva (of *Vanessa urticæ*, at any rate). The wings were probably preceded by appendages on all segments of the body, and these probably had a respiratory function in those terrestrial insects from which probably all forms, whether now aquatic or terrestrial, have been derived.

With regard to this communication, it is pointed out by Dr. E. Haase † that the structures now discovered were seen in 1822 by Chabrier in *Macroglossa stellatarum*, that Kirby and Spence distinguished them as the prothoracic "tippets" (patagia), from the mesothoracic wing-covers (tegulæ); Burmeister and Westwood have also mentioned them. In 1870 Speyer gave a detailed account of them, and pointed out that though they were found only among the Lepidoptera, they could not be regarded as characteristic inasmuch as they varied so much in different members of the order. They are not to be regarded as anything more than secondary dermal folds, thickly scaled on their upper surface only. They may have their homologues in the accessory dermal folds of the Diptera, and the patagia-like structures which are found on the prothorax of some Hymenoptera.

Colour of Pupæ.‡—The cause of the relation of pupal colour to that of the surface on which the larval skin is shed, is the subject of experiments by Mr. E. B. Poulton, who confirms Mr. T. Woods' results.

The metallic colour common to the pupæ of the Vanessidæ can be controlled by choosing appropriate surroundings for the larva before pupation; a gilt surface rendering the colour more metallic; a black almost does away with it. The author finds that the colour corresponds with the length of time the larva has been on such a surface before pupation, and that it acts before the moult; the colour affects neither ocelli nor the sensitive spines exclusively. Experiments were made with an apparatus by means of which the larvæ could be suspended partly over a black and partly over a metallic surface, and the author concludes that there is either some terminal organ in the skin, which is affected by the surrounding colour, or that the colour acts directly on some superficial element in the larval tissues without the intermediation of the nervous system.

* Zool. Anzeig., ix. (1886) pp. 615–8. † Tom. cit., pp. 711–3.
‡ Trans. Entom. Soc. Lond., 1886, pp. xlvi.–xlviii.

Structure and Life-history of the Cockroach.*—Prof. L. C. Miall and Mr. A. Denny have published a work on the structure and life-history of the cockroach (*Periplaneta orientalis*), which they hope, and we expect, will serve as an introduction to the study of insects. They have the aid of Prof. F. Plateau in dealing with the respiratory movements of insects, of Herr J. Nusbaum when treating of the embryonic development, while Mr. S. H. Scudder writes on the cockroach of the past. The work is illustrated by 125 woodcuts, many of which are new, and most of which are good, and references are given to the monographic writers and to those who have specially treated of various organs. In an appendix there is a list of the parasites of the cockroach; the authors do not seem to be aware of a popular article, conceived in a scientific spirit, written several years ago by Prof. Ray Lankester on this subject.

Relationship and Relative Age of Noctuæ and Geometræ.†—Herr L. Knatz has studied *ex ovo* the larvæ of various Noctuæ and Geometræ; as to the former, he finds that the larvæ have not always at first their full number (sixteen) of legs, and that at such stages they exhibit the mode of movement and other characteristic peculiarities of the Geometræ. He concludes that if ontogeny is an epitome of the phylogeny, it is justifiable to suppose that the Noctuæ are of later development than and derived from geometrid forms. Further proofs of this position are to be found in the more complete character of the *Noctua*. The author suggests that the examination of the young stages of insect-larvæ, especially of the Lepidoptera, may clear up some points in the phylogeny of the larger divisions, and aid the work of embryology. It may, however, be pointed out that the author makes no reference to a view widely held, and thus expressed by Balfour:‡—"The characters of the majority of existing larval forms of insects have owed their origin to secondary adaptations."

Forms of Caterpillars.§—In studying the young forms of caterpillars, Herr L. Knatz found that many Noctuæ caterpillars are exactly like Geometræ forms, and that it is only after the second skin-casting that they acquire the originally absent seventh and eighth pairs of legs. Similarly, the subsequently naked Noctuæ forms are more or less hairy in their younger stages. The same is true among Geometræ in *Lophopteryx camelina* and *Saturnia pyri*. The two families are regarded as most closely allied, and the Geometra form of caterpillar ("Spannerraupe") is older than the Noctua type ("Eulenraupe").

Primitive Insects.‖—Prof. B. Grassi, in his studies on the primitive Tracheata, gives a detailed account of *Japyx*. The purely systematic relations, the geographical distribution, and the anatomical facts are discussed in order. Some embryological facts are also noted. The segmentation of the *Japyx* ovum is like that of the typical insects. As in *Hydrophilus*, *Gryllotalpa*, and the Collemboli, there is a dorsal organ, which Grassi is inclined, with Korottneff, to regard as a sort of stopper closing the "umbilical passage." The author also maintains the formation of an amnion.

Japyx and *Campodea* are closely related, and the characters which connect them with Chilopoda on the one hand and Collemboli on the other

* 'The Cockroach. An Introduction to the Study of Insects.' 8vo, London and Leeds, 1886, 224 pp. (125 figs.).

† Zool. Anzeig., ix. (1886) pp. 610–2.

‡ Comp. Embryology, i. p. 352.

§ Festsch. Ver. f. Naturk. Kassel. Cf. Naturforscher, xix. (1886) pp. 408–9.

‖ Atti Accad. Gioenia Sci. Nat. Catania, xix. (1885) 5 pls. Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 40–2.

are emphasized. He weighs the arguments in favour of *Japyx* and *Campodea* being degenerate rather than primitive, but firmly maintains the latter, regarding them as approximately ancestral forms of the winged insects.

Anatomy of Machilis.*—Continuing his researches on primitive insects, Prof. B. Grassi describes in detail the anatomy of two species of *Machilis*, which he compares throughout with *Japyx* and *Campodea*. From the tracheal system especially, he is inclined to regard *Machilis* as the form nearest to the primitive insect type. The structure of the two species is regarded as sufficiently distinct to warrant the erection of a special family, *Machilidæ*. The habit of the Orthoptera begins to be accentuated in *Machilis*, and more so in *Lepisma*. Grassi notes the return to the old system, to which his researches have done much to supply a new morphological basis.

Structure and Metamorphosis of the Aspidiotus of the Rose-laurel.†—The presence of this Coccidian is revealed by numerous whitish spots on the under side of the leaves of the rose-laurel. M. Lemoine finds that the female consists of an oval sac filled with eggs, with neither antennæ, eyes, nor legs. The adult male possesses long antennæ, four large eyes, two wings, balancers, and well-developed legs. The author has studied the whole series of changes passed through by male and female during development. Both sexes are similar up the third age, i. e. after the second ecdysis; the female stops here; but the male goes on through a fourth ecdysis, when it becomes a nymph, and then after a fifth is the perfect insect. The result of these researches does away with the supposed exceptional characters of the development of this insect.

β. Myriopoda.

Light-perception by Myriopods.‡—Fourteen years ago Pouchet showed that muscid larvæ without eyes were still sensitive to light, and Graber has recently in some striking experiments extended the same conclusion. Prof. F. Plateau gives a careful historical survey of what is known in regard to light-sensitiveness among Invertebrates, and reports the result of his own recent researches on blind myriopods.

His method of experiment was manifold. That of Pouchet, that of Graber, and two other modifications were employed in order to determine whether the blind myriopods were able to perceive light, while in another series M. Plateau sought to ascertain the rapidity of perception.

His chief results are summed up as follows:—The blind chilopod myriopods perceive the daylight, and are able to choose between it and darkness; in the chilopod myriopods provided with eyes, and in those without these organs, a considerable time must elapse before the animals perceive that they have passed from relative or complete obscurity to daylight; the length of this latent period is not greater in the blind myriopods than in those with eyes; owing to the general slowness of perception, blind myriopods, although sensible of the light, may cross a dark space of small extent without perceiving it, or being able to find it again when they have left it; the rapid search for a hole in the soil is explicable, not only as a flight from the light, but as an expression of the necessity for a damp environment, with which the greater part of their body may be in direct contact.

* Atti Accad. Gioenia Sci. Nat. Catania, xix. (1885). Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 92–4.

† Comptes Rendus, ciii. (1886) pp. 1200–3.

‡ Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 431–57.

Morphology of Scolopendrella.*—Prof. B. Grassi gives a detailed account of *Scolopendrella*, in its systematic, geographical, and anatomical relations. The affinities of *Scolopendrella* with *Pauropodi*, with fossil myriopods, with Chilopoda and Diplopoda are discussed. In none of these orders can *Scolopendrella* be incorporated. Without as yet definitely stating the systematic position of *Scolopendrella*, Grassi advances various arguments in favour of relationship with *Machilis, Japyx, Campodea*, &c.

δ. Arachnida.

Affinities of Arachnida.†—Herr W. Schimkiewitsch discusses the limits and relationships of the Arachnida, with a critical review of the history of opinion and investigation on this subject. (1) Haller's separation of the Acarina he regards as sufficiently answered by Cronenberg. (2) The proboscis of the Pycnogonidæ he compares to the rostrum of spiders; the mandibles are the homologues of the chelicerae; and the four pair of appendages in the two types also correspond. As to the palps and oviferous

Aberrant Forms.

The number of unjointed appendages and stigmata by which the bundles of tracheæ open, corresponds to that of the segments of the body.

<table>
<tr><td colspan="5">Two anterior pairs of appendages become buccal.</td><td>Peripatus.</td></tr>
<tr><td colspan="5">The appendages become jointed.</td><td>Pauropus.</td></tr>
<tr><td rowspan="2">The head-lobe loses the antennæ, and the posterior segments of the abdomen (post-abdomen) lose their appendages (and their stigmata).
Embryonic state of Arachnida.</td><td rowspan="2">The segments which correspond to the abdomen of the Arachnida each bear a pair of appendages.
Chilognatha.</td><td colspan="3">The third pair of appendages become buccal.</td><td rowspan="3"></td></tr>
<tr><td>Chilopoda.</td><td>Scolopendrella and Collembola (Thysanura).</td><td>Insects.</td></tr>
<tr><td>The abdomen only retains one pair of appendages; the tracheæ are replaced by lungs, of which the number is reduced to four pair.
Scorpionidæ.</td><td colspan="4"></td></tr>
</table>

appendages, the former are comparable to the palps of spiders, while the latter perhaps arise from modified development of the maxillary endopodium. The *Pycnogonidæ* are at once primitive and arrested forms. (3) In regard to the Linguatulidæ and Tardigrada, the author does not consider Graff's

* Mem. R. Accad. Sci. Torino, xxxvii., 2 pls. Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 51–4.

† Arch. Slav. de Biol., i. (1886) pp. 309–19.

proposal to rank them along with Myzostomidæ in the class Stelechopoda is as yet warranted. (4) After balancing the arguments in regard to the wider homologues of the Arachnida, he compares spiders with insects. The insect antennæ have no homologues, but embryonic labra correspond to rostrum, mandibles to cheliceræ, first maxillæ to maxillæ, second maxillæ to first pair of legs, and then three pairs of legs are left to each. (5) So he compares the larva of Chilognatha with that of Acarina; the antennæ of the former are again without counterpart in the latter, but mandibles correspond to cheliceræ, maxillæ to maxillæ, three pairs of legs to the three pairs of thoracic ditto, and lastly, the myriopod segments with two pairs of appendages in the adult, to the abdominal zonites of the latter. (6) Schimkiewitsch maintains the Crustacean character of *Limulus*, and regards the first two appendages of the latter as equivalent to the Arachnid cheliceræ and maxillæ. The abdominal appendages of the *Limuli* are represented by the embryonic abdominal appendages of Arachnids. (7) After noting the ancestral character of *Pauropus*, the author sums up in the tabular survey which appears on the preceding page.

Embryology of the Scorpion.*—Prof. A. Kowalevsky and M. A. Schulgin have investigated the embryology of the scorpion, *Androctonus ornatus*.

1. *The differentiation of the germinal layers.*—Segmentation begins in the uterus; no cells or nuclei occur in the yolk; a single-layered blastoderm is formed at one pole. In the middle of the lower surface of the layer some cells are pressed in to form the beginning of the endoderm. On the surface of the round germinal disc a round groove is formed, uniting the central mass. In this an albuminous fluid gradually accumulates. The margins of the groove grow up, arch over, meet and inclose the germinal disc. Into this duplicature of the upper layer cells from the endoderm penetrate. The inner layer of the embryonic membrane thus formed is continuous with the endoderm and is the amnion proper, the outer layer passes into the ectoderm, and is the serous envelope. Between the two a few mesoderm cells can be detected. The round germinal disc elongates, and one pole (the future post-abdomen) becomes thicker and longer, the other (the future head) remains thin and broad. Meanwhile yolk-cells from the disc wander inwards, become amœboid, and dissolve the yolk mass.

2. *The formation of the alimentary system.*—Ectodermic invaginations form the fore and hind gut. The muscular sheath is formed from the mesoderm. From the lower, properly speaking endomesoderm layer, the true endoderm is separated off as a thick row of cells closely apposed to the yolk, round which the various layers then begin to grow. The endoderm cells become filled with the yolk material, and form a thick inclosing layer. When the yolk is completely surrounded, the post-abdomen developes as an elevation composed of all the three layers. The endoderm tube becomes connected with the hind-gut invagination. The liver lobes are developed, and the mid-gut acquires floor, sides, and roof.

3. *Mesoderm and vascular system.*—After the differentiation of the endoderm, the mesoderm begins to be differentiated. It remains longer than the other layers below the germinal disc, and is last in growing dorsally over the embryo. The number of mesoderm segments represents that of the body. There is also a preoral segment with a cavity like the rest. The somatic layer is much thicker than the splanchnic. They pass into one another peripherally, and form on the margins of the body a complete unsplit layer.

The lateral margins of the mesoderm extend dorsally between ectoderm

* Biol. Centralbl., vi. (1886) pp. 525-32.

and endoderm, in a still unsplit layer. The marginal cells separate off from the others; those nearer the back become round, sappy, and transparent, like young ova. They move dorsally, and are the primitive blood-corpuscles. They occupy a long broad cleft, which becomes narrowed by the extension of the lateral mesoderm layers, which finally meet and fuse, first dorsally, and after a while also next the endoderm. A mesocardium is thus formed. The heart exhibits an inner endothelium and an outer muscular sheath. The valves also appear. The alary muscles are also mesodermic. Round the heart, especially dorsally, large cells accumulate and appear to form the pericardial membrane.

4. *The nervous system.*—The first traces appear, when the head appendages become demonstrable, as ectodermic thickenings in the median ventral line. Each joint of the body exhibits two elevations, (*a*) peripheral, forming the appendages, and (*b*) median, forming a segment of the nerve-cord. The ectodermal cells forming the nerve-strand proliferate, forming in so doing peculiar pits or hollow cavities, which gradually disappear. After considerable development, the fibrous substance becomes differentiated, and the ganglia are then separated from the ectoderm.

The cephalic nervous plate exhibits a paired hemispherical depression. This insinking is surrounded by a ridge. The sunk portions form the two cerebral masses, which remain for a while connected with the exterior by a cleft. Above the closure a new elevation is formed, and two pouches are produced, the first hints of the median eyes. In the sunk portion of the nerve-plate which forms the brain, the formation of pits, characteristic of the rest of the nervous development, is observed.

The median eyes arise from the same primitive nerve-plate as the brain. The peripheral portions of the fold associated with the development of the latter form two lateral pouches. These two folds approach and meet medianly, and when they meet the eyes are developed. The lateral eyes have an entirely independent origin.

5. *The coxal gland* was seen, when the nerve-cord had been separated from the ectoderm, as a paired tube, opening at the base of the second (?) pair of feet, and reaching internally to the anterior lobes of the liver.

6. *The genital ducts* were formed (*a*) from an internal funnel-shaped tube developed from the splanchnic layer, and opening into the body-cavity, and (*b*) from an external invagination forming the outer portion of the ducts.

7. *The pulmonary sacs* were first seen as simple invaginations of a space rich in blood-elements.

Microtelyphonidæ.*—In connection with his studies on primitive insect and myriopod forms, Prof. B. Grassi has described the anatomy and histology of *Kœnenia mirabilis*, representative of a new order *Microtelyphonidæ*, and forming the much desiderated intermediate form between Gigantostraca and Arthrogastra. The Microtelyphonidæ have lost the branchiæ, but have not yet acquired organs of aerial respiration. Prof. Grassi gives a comparative survey of primitive Arachnid orders.

ε. Crustacea.

Development of the Crayfish.†—Dr. H. Reichenbach has completed his memoir on the development of the crayfish, which he began almost ten years ago. His results are contained in a handsome monograph of about

* Bull. Soc. Entomol. Ital., xviii. (1886) pp. 153–72.

† Abhandl. Senckenberg. Naturf. Ges., xiv. (1886) pp. 1–137 (14 pls.).

140 pages, and are accompanied by drawings, partly due to Herr W. Winter, which exhibit unusual skill and care.

I. *Blastoderm and germinal layers.*—(1) The *egg-membranes* round the blastosphere are first described. The firm and tense chorion, the delicate blastoderm membrane, and a third structure covering part of the external surface of the chorion are noted in detail. The *contents* exhibited numerous oil-globules, yolk-pyramids, and small white yolk-elements. The central body found in the yolk is regarded as a residue of the undivided yolk. The blastoderm extends all over the yolk and is not, as Ratke supposed, confined to one region. (2) *Germinal layers, &c.* In stage A the embryo is an approximately spherical closed sac of a single layer of cells except in one region. The centre of gravity is in the hemisphere opposite the ventral plate, and thus the latter lies uppermost. The anterior region of the ventral plate exhibits the head-lappets with cells arranged in definitely concentric curves. The central portion exhibits the beginning of the ocular invagination, and the crystalline-cone-cells were also detected. Posteriorly the thoracico-abdominal rudiments were seen, and behind these a fifth large cell-plate—the endoderm disc. The mesoderm first appears at the anterior region of the endoderm plate. Stage B is characterized by the semicircular gastral groove on the endoderm plate, and this in stage C becomes annular. The mouth of the gastrula is primitively a circular, and afterwards an oval aperture with the narrower portion situated anteriorly. The formation of the primitive mouth varies considerably, and in this something more than intensity of cell growth and consequent pressures must be regarded as influential. The mesoderm developes at the passage of outer into inner layer at the anterior margin of the primitive mouth. In stage D the ventral plate is heart-shaped, and the primitive mouth becomes closed. The embryonic rudiment becomes considerably reduced both in length and breadth. The head-lobes and eye-rudiments have approached one another in the middle, and the thoracico-abdominal plates are united medianly. Reichenbach lays considerable emphasis on the differentiation of the mesoderm into primary and secondary. He describes how the endoderm cells devour the yolk-elements. (3) *General.* The third chapter contains a useful comparative survey of the relative literature. Reichenbach also calls special attention to the regular curves in which the cells of the embryo are disposed, as the beautiful plates so well illustrate.

II. *Body-form and systems of Organs.*—After describing at length the features of the embryo when the three nauplius appendages are distinctly apparent, the author gives a detailed account of the next five stages—(*g*) with developed masticatory appendages, (*h*) with developed walking limbs, (*j*) with abdominal appendages, (*k*) with well-developed eye-pigment, and lastly (*l*) the liberated embryo. Of these modifications it is hardly possible to give any brief account.

Derivatives of the ectoderm.—(1) The history of the external skin is first described. Particular attention is directed to the internal prolongations which serve, along with certain mesoderm elements, for the insertion of muscles, for sinews, supporting beams, &c. In the section of the carapace the interstices contain large wandering cells with yolk-like contents. (2) *The nervous system.* In the four head-segments of the nauplius, four pairs of ganglionic pads appear as ectodermal thickenings; of these the two last are separated by a shallow median furrow, which extends to the budding zone of the thoracico-abdominal rudiment. The first pair of ganglionic rudiments belong to the eye, the second and third form the brain, the fourth the ventral cord. The development is thence described at great length. From the very earliest stages the large ganglionic cells

of the central nervous system are recognizable, arising in the outermost ectodermic layer. A brief account of the histology of the system is also communicated. Herr Reichenbach maintains very strongly the primitive connection between the nervous system and the other organs. The separation is a subsequent differentiation. Green-gland and third ganglionic mass, eye and brain, &c., are primitively united. (3) *The eye and ear.* The eye results from three factors, (i.) epidermal, (ii.) an ectodermic invagination or eye-fold, (iii.) an optic ganglion. The epidermal layer appears very early, rising on the head-lobe like an appendage, at first with a single layer, afterwards with four or five. Its elements gather in groups of eight elongated cells. Four of these become closely united and form the peripheral covering and cuticular corneal facets. They are called Semper's cells. The other four are the mother-cells of the crystalline cones, which they form peripherally, while their inner processes are prolonged inwards to unite finally with portions of the eye-fold. The other cells of the epidermal layer become the pigment-sheaths of the individual eyes. The eye-fold appears as a flat groove on the head-lobes, is deeply invaginated in the nauplius stage, and forms a solid mass of cells. It soon forms two compact and complicated balls of cells, with the eye-fold long persisting between them. The peripheral ball becomes united to the processes of the crystalline cones; its elements arrange themselves radially, become grouped in sixes or eights, and form the retinula-cells, which form internally the layer of rods. The inner ball comes into intimate connection with the outer and with the optic ganglion. The third factor or optic ganglion arises in the nauplius stage as an ectodermal thickening in the optic segment, in direct contact with the brain and the eye-fold. Its details are then described. Reichenbach emphasizes the analogy between the Arthropod and Vertebrate eye-development. The invagination which forms the auditory sac appears in the embryo with incipient abdominal feet, but is not, of course, differentiated till afterwards. (4) *The gills.* Ratke's results are simply confirmed. (5) *The green-gland* appears in the stage with incipient walking legs as an invaginated sac on the basal joint of the second antennæ. Its history is briefly traced through a few phases. (6) *The hind-gut* arises in front of the closure of the blastopore as an ectodermic invagination. Herr Reichenbach gives a brief account of its slight changes, and of (7) the greater modifications of the *fore-gut.*

Derivatives of the endoderm.—In this chapter Herr Reichenbach traces the endoderm from the circular disc sunk into the yolk and forming a closed sac, to its final differentiation into mid-gut and liver. He devotes special attention to the relation of the endoderm to the yolk, e. g. in relation to the appearances known as secondary yolk-pyramids. The usual bibliographic review closes the chapter.

Derivatives of the mesoderm.—The *heart* is seen pulsating in the stage with incipient walking legs. It lies under an arched portion of the ectoderm which previously exhibited an accumulation of large loose mesoderm-cells. This mesodermic rudiment is symmetrical; the loose elements unite to form the ventral wall, whence the sides grow up and meet dorsally. The pericardium and mooring strands soon appear, and at a very early stage the wall of the heart exhibits two layers. The *blood-vessels* also arise from wandering mesoderm-cells, which form strands, by-and-bye exhibiting a lumen. The component cells are very small and flat. The development of the main vessels is briefly noted. The *blood-sinuses* are morphologically persistent portions of the primitive segmentation cavity, as indeed are also the cavities of heart and vessels. The elements of plasma or blood-serum are primarily mesodermic, probably plus additional migrations from

the endoderm. In discussing the *musculature*, Reichenbach raises the problem of the origin of the body-cavity, and notes especially that the mesoderm-cells in the abdomen are congregated in masses representing the segments, and that these exhibit a lumen, apparently progressive from before backwards. This certainly appears at a late stage, but seems comparable with the segmented body-cavity of related types. Finally the author was able to find after prolonged search what seemed to be the first rudiments of the reproductive organs, but was unable to determine from what layer they originated.

Eyes of Crustacea.*—Mr. W. Patten gives an account of the structure of the eyes of several Crustacea, and especially of those of *Penæus*.

(*a*) The *cornea* is divided into square facets, and consists of two layers. Below the cornea is a thin, continuous layer—the *corneal hypodermis*—to which the corneal cuticle owes its origin. (*b*) Beneath this is the much thicker *ommateal hypodermis*, of numerous *ommatidia* each consisting of 19 or 20 very long cells, extending down to the basal membrane. They are arranged in four circles, and the nuclei of each group are at the same level, in specially enlarged or pigmented portions. (*c*) The innermost group consists of four colourless cells—the *retinophoræ*, forming an inverted pyramid. The outer ends of the retinophoræ are thickened and contain the nuclei; below the nuclei the cells are filled with a mass of less consistent, finely granular protoplasm; then follow the conical, four-cornered *crystalline cones*, which are nearly half as long as the ommatidia themselves. The narrowing apex of each of these square pyramids is reduced to the slender, tube-like "*style*." The final expanded solid portion forms the rhabdom or *pedicel*. Near the basal membrane, the latter diverges into three legs composed of the attenuated, inner ends of the four retinophoræ, two of which have united. Each leg of the stalk is divided at its inner end into several fibres by which it is united to the basal membrane. The segments of the so-called rhabdoms of Grenacher are not secretions of the *retinulæ* (or pigmented cover-cells), but the inner ends of the retinophoræ, which terminate in the same root-like fibres as occur in nearly all hypodermic cells.

(*d*) After giving an account of the complicated structure of the pedicels, Patten passes to the *retinulæ*. Seven of these oddly-shaped, pigmented cells surround the retinophoræ. The outer parts of the retinulæ seem to terminate with the knob-like swellings containing the nuclei, but they are really continued onwards as extremely delicate membranes. These form a sheath round the style, though this is not always evident. The pigmentation and relations of the retinulæ are described in detail. (*e*) The pigmented collar of the retinophoræ is formed by a third circle of four cells in two pairs. The cells are continued inward to the basal membrane as slender colourless rods or bacilli, and outwards to the surface of the ommatidium, as four delicate fibres, producing four minute impressions at each corner of a corneal facet. The cell-stalks or bacilli, which are fastened by root-like fibres to the basement membrane, are elongated, hyaline fibres, with node-like thickenings at intervals. It is striking that these prominent and simple structures have hitherto remained unobserved. In the spaces between the diminished inner ends of the ommatidia is a third group of cells, ensheathing the inner ends of the retinulæ. They contain a mass of yellowish, fat-like crystals.

(*f*) The *basal membrane* is extremely complicated. It consists of connective tissue fibres, sometimes fused to form hyaline masses, connected

* MT. Zool. Stat. Neapel, vi. (1886) pp. 542–756 (5 pls.). Cf. Mollusca, *supra*, p. 53.

by a network of fine fibres. After noting the disposition of the fibres, Patten describes the arrangement of the ommateal cells on the membrane, and the bundles of nerve-fibres by which it is penetrated. The investigation is extended to *Galathea*, *Palæmon*, *Pagurus*, *Branchipus*, *Orchestia*, and to *Mantis religiosa*. Instead of following these, however, it will be more useful to summarize the author's general remarks upon Arthropods.

General.—The compound Arthropod eye consists of a double layer of cells, the ommateum and the corneal hypodermis. The latter always gives rise to the corneal facets. Just as in Mollusca, the evaginate, convex arrangement of the ommatidia has resulted in the expansion of the outer ends of the latter, and a reduction of the retinulæ to protective purposes, as in Arthropods. The retinophoræ of each ommatidium form four equivalent cells. "The terminal, cuticular secretions, or rods, are transferred to the axial faces of the outer ends of the retinophoræ; they there unite to form the crystalline cones, to accommodate which the outer ends of the retinophoræ are enlarged into a cup-like expansion—the calyx, while their inner ends are reduced to a slender tube, or style, serving at once as a support for the calyx, and as a protective canal for the axial nerve. Reasons are given for regarding the pedicel as a reflector. The convexity of the eye is a solution of the problem of arranging the layer in the most economic manner. The greater the number of ommatidia, the greater the curvature of the surface and depth of the layer. The colourless cells are the essential elements, the retinulæ have not, as Grenacher supposed, anything to do with the formation of the "rhabdom," which is formed by the continuations of the crystalline ones. The crystalline cone-cells are the essential elements, both morphologically and physiologically.

After a discussion of relative observations, Patten comes to the following general conclusions:—(1) "That the ancestral forms of all Arthropods were probably provided with a small number of eyes placed on each side of the head; (2) these eyes consisted of closed optic vesicles formed by invaginations lying close beneath the hypodermis, which formed a continuous layer over them; (3) the deep wall of the vesicle formed a retineum, similar to that of worms and certain molluscs, composed of colourless double retinophoræ, bearing terminal rods and containing an axial nerve-fibre; each retinophora was surrounded by circles of rodless pigment-cells; (4) the outer wall of the optic vesicle secreted a cuticular vitreous body, similar to that found in the optic vesicle of worms (Alciopidæ) and molluscs (*Fissurella*, &c.); (5) the hypodermis overlying the optic vesicle (corneal hypodermis) gave rise to a lenticular thickening of the cuticula, the lens." Modification has been in two directions: (1) an increase in the number of ocelli, with a decrease in the number of their ommatidia, or a decrease in the number of ocelli with an increase in the number and complexity of the ommatidia.

The eyes of *Euphausia*, &c., are briefly described, and the development of Arthropod eyes is briefly discussed. Müller's theory of mosaic vision, as advocated by Grenacher, is subjected to searching criticism and rejected. Morphologically, the seat of vision ought to be in the crystalline cones, the necessary nerves are only to be found in the crystalline cones, and finally the most perfect optical conditions are obtained in the crystalline cones, therefore the cones are the percipient elements. In eyes with lenticulate facets, an inverted image of those objects lying within the axis of the ommatidia will be formed upon the crystalline cone. In *Musca* or in *Mantis*, for instance, "there is absolutely nothing to prevent the formation of a perfect image, not upon one or two nerve-fibres whose surface is in no wise proportional to the size of the image, but upon a complete and

perfect series of fibrillæ, whose extension in all three directions is sufficient to receive the whole of any image formed by the corneal lens. The lack of focal accommodation in the lens is balanced by the depth of the retinidium. The theory of vision is discussed in some detail.

An interesting survey of other groups is given, showing how the above view of the structure of the molluscan and arthropod eye unifies that of all the groups. Another chapter is devoted to a development of the idea of a "Funktionswechsel" in the development of sense-organs, and especially eyes which were, according to Patten, not primitively perceptive, but absorptive of solar energy, *heliophagous.* Lastly, we repeat the author's classification of eyes:—

OMMATIDIA.

I. Ommatidia diffuse.	A. Chromatophores; (modified ommatidia)				Cœlenterates (?) Molluscs. Crustacea (?)
	B. Isolated ommatidia;				(universal ?)
II. Ommatidia aggregate.	A. Ommatidial tracts;			retinidial cuticula, thin; no rods developed	(Mollusca).
	B. Pseudo-lenticulate;			ommatidial tracts, non-invaginate, or but slightly so; rods form a lens-shaped, unprotected protuberance.	*Arca* and Cœlenterates.
	C. Invaginate	(*a*) retineum;	(1) primary	optic caps or vesicles; corneal cuticula forms a vitreous body ± primary lens	Cœlenterates, Molluscs, Worms.
			(2) secondary	optic vesicles; triploblastic; vitreous body ± primary * or secondary lenses	Arthropod-ocelli. Stemma.
		(*b*) retina;		optic vesicles; anterior wall forms the retina; triploblastic; cellular lens	*Pecten* and Vertebrates.
		(*c*) ommateum;		optic vesicles; cuticular lens, single and secondary	Spiders, *Scorpio*, *Limulus*.
	D. Evaginate; ommateum,	(1) monoblastic;		corneal cuticula present, but no lens is formed.	*Arca*, *Pectunculus*.
		(2) diploblastic;		a modified optic vesicle; corneal cuticula present, forming no lens or many.	Compound eye of Insects and Crustacea.

Development of Compound Eye of Crangon.†—Dr. J. S. Kingsley gives a preliminary notice of his investigations into the development of the compound eye of *Crangon,* in which it is shown to arise from a single

* A primary cuticular lens is one formed by the corneal cuticula within the optic vesicle; a secondary one is formed by the cuticula of the hypodermis overlying the optic vesicle.

† Zool. Anzeig., ix. (1886) pp. 597–600.

invaginated pit; this fact proves that the compound eye is not to be regarded as derived from coalesced ocelli; similar observations have been made by Sedgwick on *Peripatus* and by Locy on spiders, while Bobretzky and Reichenbach saw, but misunderstood the nature of, the pit. There is nothing in the development of the eye of *Crangon* which warrants the assumption that it or its stalk is an appendage homodynamous with the other appendages. The author sides with Patten in his criticisms on Grenacher's account of the structure of the eye of the adult Decapod; he thinks that the comparisons between the eyes of Arthropods and those of Vertebrates "are not so absurd as they would have seemed a year ago."

Crustacean Carapace.*—Dr. H. Ayers has recently † restated the theory and collected the evidence that the carapace is *not* the fused terga of the head and thorax, as it is usually stated to be, but that it is in reality the coalesced terga of the antennal and mandibulary somites, and that the "cervical suture," instead of being the line of separation between head and thorax, indicates the junction of these somites. The "episterna" of Milne Edwards are really portions of the sternum cut off by false sutures.

Abnormal Limbs of Crustacea.‡—Prof. E. Duns describes certain abnormalities in the thoracic appendages of *Carcinus mænas*, *Cancer pagurus*, and *Nephrops norvegicus.* In the two former the abnormality consists of a bifid or trifid character assumed by the terminal joint of one or more of the appendages, more noticeably the chelæ; accompanied in one case by an elongation of the three terminal joints. In *Nephrops*, the protopodite of the chela, which should be produced so as to form, with the dactylopodite, a claw, is not so produced. He considers it probable that these abnormalities are due to the injury of the soft parts just after an ecdysis. It is noteworthy that the mutilation occurs more often on the left than on the right side.

Mimonectes, a new genus of Amphipoda Hyperidea.§—Mr. C. Bovallius remarks that the genus now described by him appears to afford the first example of mimicry among the Amphipoda. The enormous globular development of its body gives it a striking resemblance to a little jellyfish, the straight slender legs and the minute tail hanging down as filaments. The new family—Mimonectidæ—to be formed for its reception, may be defined as "Hyperids with the head and a part or the whole of the pereion developed into an enormous balloon-shaped globe. Ocelli not united but dispersed on each side of the head. The upper antennæ long, more or less straight; the lower small, four-jointed. The mandibles without palp. The maxillipeds well developed." The interior of the pereion forms a bladder containing a fluid. Three species are described—*M. Loveni*, *M. sphæricus*, and *M. Steenstrupii*—which were all found in the Atlantic. Under the first form the author enters into full details of the anatomy, and especially of the nervous system.

The Genus Entione.||—MM. A. Giard and J. Bonnier agree with Kossmann in distinguishing the *Entoniscus*-parasites of the Porcellanidæ from those of the Crabs, to which the name *Entione* should be applied. Almost all the species of crabs found on the French coast seem to have a special species of *Entione*, and these appear to be referable to a number

* Amer. Natural., xx. (1886) p. 978.
† Bull. Essex (U.S.A.) Inst., xvii. (1886) pp. 49–59 (2 pls.).
‡ Proc. R. Phys. Soc. Edin., ix. (1886) pp. 75–8 (1 pl.).
§ Nova Acta Soc. Upsala, xiii. (1886) No. 4, 15 pp. (3 pls.).
|| Comptes Rendus, ciii. (1886) pp. 645–7.

of subgenera parallel with the crustacean genera on which they live. The authors distinguish *Grapsion*, *Portunion*, and *Cancrion*, and give some further notes on the third of these.

The study of the development of *Entione* is accompanied by many difficulties; it is certain that for a considerable time the embryos are free, and during this period it is difficult to follow their metamorphoses; they avoid light, and it is therefore to be presumed that crabs become infected during the night. From what the authors have been able to see, they conclude that the males of the different genera pass through a Cryptoniscus-stage.

Development of Copepoda.*—M. F. Urbanowicz has investigated the development of several species of *Cyclops*. The ovum undergoes total segmentation. One large sphere has its central extremity constricted off, to form a central cell of unknown destiny. The result of segmentation is a blastosphere containing nutritive yolk in the central cavity. The external cells divide radially and superficially. One specially large cell is invaginated and multiplies to form the entoderm cells, while the slightly swollen internal extremities of ectoderm cells are constricted off to form the primary mesoderm cells. A stomodæum is formed by invagination, a mesoderm cleft forms the general cavity, and an endodermic cavity appears as the mesenteron. Meanwhile the embryo elongates slightly; the mesoderm cells are grouped dorsally to form three pair of muscle-bundles for the extremities; while ventral and anterior dorsal ectodermic thickenings form the ventral and dorsal ganglia, and apparently endodermic cells begin to form the typical secondary mesoderm.

When liberated, the larva exhibits no trace of segmentation, the two portions of the nervous system are still unconnected, the anus is not yet formed, &c. The appearance of the eye and kidney, and the development of muscle from amœboid mesoderm cells are then noted.

In the post-embryonic life the mesoderm bands increase in length, and the segments of the body are formed. The body-cavity is enterocœlous. The proctodæum is evident in a larva of thirty-six hours. In a nauplius of twelve hours lateral ectodermic thickenings unite the anterior part of the brain with the ventral ganglion, but the secondary posterior portion of the brain, bearing the eye, remains long separate. The growth of the double ventral nerve-cord is then described. The kidney atrophies after hatching. A pair of secondary kidneys appear in the second segment. The latter probably correspond to segmental organs, the provisional kidney to the analogous organ in the trochosphere larvæ of Annelids. The genital cells form an unpaired organ towards the dorsal surface of the larva. The shell-secreting dorsal organ is then noted.

Cypris and Melicerta.†—Mr. E. Roberts records an attack which he saw of a *Cypris* on a full-grown *Melicerta ringens*. The *Cypris* at first seemed to be digging its claws into the bottom of the tube, as if to tear it from the leaf; then it climbed up and scratched one side for some time, then the other, about half-way down, until there was a large hole in it. It then went to the bottom of the tube, and whilst there the *Melicerta* came out at the top and expanded its discs. The *Cypris* immediately climbed to the top, and the *Melicerta* as suddenly disappeared; and the former, with its head down and its claws stretched out, began to scratch the middle of the tube again, until part of it broke off, leaving half the *Melicerta* exposed. The *Cypris* then left it, and a number of minute, round, trans-

* Kosmos (Polish), 1885. Cf. Arch. Slav. de Biol., i. (1886) pp. 663–7.
† Sci.-Gossip, 1886, p. 239.

parent bodies appeared, which seemed to settle upon the *Melicerta* as it swayed backwards and forwards in its uncovered state. The next day the *Melicerta* was very lively, and was busy repairing its tube, as if nothing had happened.

New Parasitic Cymothoid.*—M. Z. Fiszer describes a new Cymothoid genus parasitic in the fresh-water fish *Idus Waleckii* (Dyb.) = *Cypricus lacustris* (Pall.). In structure it resembles *Livoneca sinuata* (Rochet); while in mode of life it approaches the Isopods, and especially *Rutoniscus*. It is a true parasite, not a commensal.

Vermes.

Origin of Annelids from the Larva of Lopadorhynchus.†—Herr N. Kleinenberg devotes the first chapter of his essay to observations on the germinal layers, in which he gives a critical account of the investigations on this subject. He is himself of opinion that mature Cœlenterates have no mesoderm, and that the median germinal layer of embryos of higher Metazoa is a mere conventional idea, which does not correspond to the fact. What has hitherto been called the mesoderm is either the sum of independent heterogeneous rudiments which arise within the primary germinal layer, or is a single rudiment of a definite tissue or of organs which eventually undergoes partial metamorphosis. As a rule, well-marked ectodermal muscle-rudiments and paired appendages of the archenteron are regarded as part of the median germinal layer. In every case the homology of organs must be established by their genetic relations to the two layers of the cœlenterate body. These layers give rise to special tissues which have no power of producing fresh tissues, and, on the other hand, the tissues and organs which arise directly from one of these layers are able to bring forth other tissues and organs; in no living part of the body is the internal force of metamorphosis completely lost. The genetic relation between any given organ and the primary germinal layer is not lost; it is only separated by the intercalation of one or more intermediate stages; none of these intermediate stages are represented by an indifferent germinal layer, but always by a tissue or organ with a specific activity. Thus, the permanent peritoneal investment of the enteron of *Lopadorhynchus* does not arise directly from the ectoderm, and still less from any other germinal layer, but from the metamorphosis of part of a quite specific rudimentary tissue—the muscular layer. The peritoneal epithelium consists of altered muscle-cells, and as the muscle-plates arise directly from the ectoderm, the latter are secondary and the former tertiary descendants of the ectoderm.

This mode of regarding the subject appears to open out a further field for embryological investigations; where an organ does not arise directly from a germinal layer, the nature of the permanent or temporary intermediate organ must first be settled, and in the second place we must investigate how far this genetic series is constant within one or more classes of animals. The removal of the mesoderm frees embryology of an embryonic constituent.

The second chapter deals with the development of the external body form of *Lopadorhynchus*, which is described in detail; the youngest larvæ found had an almost spherical form, which is divided into two equal halves by a completely closed circlet of cilia; the upper may be called the umbrella, the lower the subumbrella. Both ectoderm and endoderm are rather thick, and the latter incloses a spacious archenteric cavity. Large

* Kosmos (Polish), 1885, p. 458. Cf. Arch. Slav. de Biol., i. (1886) p. 466.
† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 1–228 (16 pls.).

flagella become developed and work actively and rhythmically at first. The stomodæum after a time disappears, to make way for the definite mouth, which appears at the same spot as the external stomodæal orifice; its presence allows one to distinguish a ventral from a dorsal surface. Just below the stomodæum the ectoderm becomes again depressed in the middle line, and forms a narrow, short, blind tubule, which is directed obliquely inwards and downwards; its inner wall is covered by fine cilia, which appear to have a very complicated motor rhythm.

In the third chapter the author deals with the youngest larvæ, and in the fourth with the development of the various tissues; the fifth is a contribution to the theory of the neuromuscular system.

The larva of *Lopadorhynchus* in its simplest form—that is, when it commences to lead an independent free life, but is not yet laden with the extensive and numerous rudiments of the annelid organism—is an almost spherical body, sharply divided into an upper and a lower hemisphere. On the lower one lies the mouth formed by a stomodæum. The endoderm, and, for the greater part of its extent, the ectoderm, is a single uniform layer; between the two are a few contractile cells. In the prototroch, at the boundary of the two hemispheres, there is a special and proportionately rich organization—there is the locomotor organ, a simple ring of large cells, with strong cilia, with which is connected an upper and a lower row of smaller ciliated cells, a nervous system, and a circular muscle. The nervous system is composed of regularly disposed fibres and cells; the chief part of the fibres forms a closed ring, and the fibres are the processes of two kinds of ganglia, one of which is called automatic and the other reflex. At the point where, later on, the cephalic ganglion arises there are a few ganglionic cells, which are clearly not constituents of the larval system, in the way of formation.

The central nervous system of the larva of *Lopadorhynchus* may be regarded as consisting of a fairly diffused nervous plexus, the processes of which partly pass into other tissues, and so form the peripheral system. But, within this plexus, a further centralization is brought about, the closed system of the nervous ring being the controller of the whole system. Such a system is, as a permanent arrangement, found among the craspedote Medusæ, and there are essential resemblances between the two. The topographical relations of the margin of the umbrella with the velum, and of the prototroch with the general body are the same, and both are the chief organs of locomotion. Their contractile elements are, however, very different, in correspondence with the difference in their structure. If we suppose that the prototroch of the annelid is the homologue of the margin of the umbrella and velum of the medusa, then the Annelid-larva might be classified in or near the Hydro-medusæ, and the stem-form of the annelids is to be sought for in a form which stands much nearer the craspedote Medusæ than the hypothetical organism which Balfour took to be the originator of *Pilidium*, *Trochosphæra*, *Tornaria*, *Actinotrocha*, and the larvæ of Echinoderms and Brachiopoda.

Organogeny of the Hirudinea.*—Herr J. Nusbaum has studied in *Clepsine complanata* Jav. the later development of the Hirudinea. After referring to unfavourable technique the opinion of Hoffmann as to the absence of proper germinal layers, Nusbaum discusses, in the first place, (1) the development of *the body-cavity and of the muscular and connective tissue.* As in higher worms, each mesodermic band divides into 23 somites, in each of which a cavity appears. The replacement of the somite-spaces

* Arch. Slav. de Biol., i. (1886) pp. 320-40 (4 pls.) and pp. 539-56.

by the general body-cavity is described. The dorso-ventral muscles are mainly derived from the elements of the disintegrated partitions. The circular and longitudinal muscles and a large portion of the connective tissue are developed at the expense of the parietal layer of the mesoderm. The connective tissue which forms the sheath and support of the nervous system is formed from ectodermic elements, which at a less advanced phase appear as a thick mass in the anterior portion of the embryo. All the rest arises from the mesodermic elements which result from the disintegration of the somite walls.

2. *The alimentary canal.*—In regard to this point Hoffmann and Whitman have arrived at opposite results, the former deriving the digestive tube from the mesoderm, the latter from the primitive endoderm. Nusbaum has shown the correctness of Whitman's conclusion. Even the epithelium lining the cavity of the proboscis is of endodermic origin, and the posterior intestine has a similar history.

3. The *nephridia* appear as accumulations of mesoderm cells, as differentiations of the parietal sheath, in the anterior angle of each somite, abutting directly on the anterior septum. They appear in all the segments, but are reduced in the most posterior. Certain large reproductive cells are locally associated with their development. The appearance of the cavity and subsequent stages are carefully described.

4. *The reproductive organs.*—After giving a full account of the anatomy and histology of the reproductive organs, the author describes their development. Eight large endoderm cells at the posterior pole of the embryo (Whitman's "neuroblasts") multiply rapidly and extend forward until finally a pair are found in each segment. As the separate somites appear, the sex-cells are found disposed at the base of the septa. They multiply rapidly and form (1) a pair of cellular masses at the boundary between proboscis and mid-gut—the *ovaries*, and (2) six groups of *sperm cells* separated by lateral diverticula of the mid-gut. At the posterior portion of the proboscis, isolated free-cells are formed, probably reduced yolk-forming cells, as in *Amphilina-Planaria* for instance. The young ovaries are solid rounded masses with characteristic cells, they are surrounded by a mesodermic endothelium. They become associated with a pair of nephridial rudiments, the expanded ends of which embrace the ovaries. The nephridium forms the oviduct, and external elements add muscle-fibres and outer membrane. Round each group of sperm cells a mesoderm endothelium is formed, and the delicate transverse canals connecting testes and vasa deferentia are formed from this envelope. The vasa deferentia represent a pair of modified nephridia. Further details of the development are given, and the free disposition of all the organs within the body-cavity is compared with what is permanent in *Gunda segmentata* and *Amphilina-Planaria.*

5. *The nervous system.*—In regard to the development of the nervous system in *Clepsine*, there has been a good deal of haziness. Nusbaum has shown its origin from a ventral ectodermic thickening forming the ventral cord, and an anterior dorsal forming the brain. The insinking of the cord is carefully described. At an early period isolated endodermic cells apply themselves to the surface of the cord, forming a sheath of flat cells—the internal neurilemma, but also sending prolongations between the elements of the nerve-cord and dividing it into three portions. These penetrating elements form a delicate network separating the cellular portion of the chain from the fibrillar. The author also notes the temporary connection of ventral blood-vessel and nerve-cord. Anteriorly the wall of the ventral vessel is seen to be prolonged into two lateral plates, which unite

directly with the membrane, separating the cellular from the fibrillar portion of the cord. Posteriorly the vessel is quite isolated, and the anterior association afterwards disappears; but there seems thus to be a special provision for nourishing the nervous system during its development.

6. *Vascular system.*—By arrangement of the dorso-ventral muscles two longitudinal partitions are formed in the body. The ovoid median *sinus* thus formed contains the nervous system, the ovaries, the two blood-vessels, the anterior and posterior portions of the mid-gut. The lateral prolongations of the digestive system and the testes lie in the marginal sinuses. The dorsal and ventral *vessels* are very different. Two solid cellular strands are formed along the alimentary tube, the one in the median ventral, the other in the median dorsal line. Both seem to arise from the splanchnic layer of the mesoderm. Each strand is differentiated into a central cord, and an external layer separated from the former by a delicate structureless membrane. The external layer forms the wall of the blood-vessel, the central strand forms the elements within.

7. *A temporary dorsal organ* is for the first time noted. It lies in the dorsal middle line, in the anterior third, and consists of a canal running into an external prominence from which long delicate threads are emitted, probably for fixing purposes.

8. *General conclusions.*—Nusbaum notes the accordance of his results with those of Salensky on *Branchiobdella*, and compares his conclusions with those of others. As to the position of the Hirudinea, his embryological results lead him strongly to maintain Balfour's opinion that they were slightly degenerate Annelids, near allies of the Chætopods.

Colossal Nerve-fibres of the Earthworm.* — Prof. F. Leydig, after referring to the views of other anatomists, gives an account of his own re-examination of the colossal nerve-fibres of the ventral ganglionic chain of the earthworm. They may present a quite homogeneous interior, even after treatment with reagents, and, again, with certain hardening fluids such as chromic and acetic acid they may exhibit certain differentiations.

A band of granular axial substance is seen in transverse sections, in which the granules have an angular form, and it is possible to convince oneself that there is an extremely fine plexus, in which the dots are the nodal points. There is, therefore, a spongioplasm, in the meshes of which a hyaloplasm is contained.

It seems that, in transverse sections, the median or larger of the colossal fibres is divided by septa arising from the cortical layer into two halves, each of which has its own axial bands. This is clearly the commencement of what in other genera is the absolute division of the fibre into two tubes (e. g. *Stylaria*). Careful observation reveals the presence of intermediate stages between the ordinary and the colossal fibres; this is best seen in the region of the ganglia.

The author directs attention to the relations between the colossal fibres and what he has already taught as to the structure of the nerves of invertebrate animals. To understand thoroughly the nature of the colossal fibres it is necessary to extend investigations to the Arthropoda, where likewise there are colossal fibres, which are true elements of the nervous system.

Annelids of the Genus Dero.†—Mr. E. C. Bousfield points out that the species of *Dero* are distinguished from the *Naides* by the absence of eyes, of corpuscles from the perivisceral fluid, and by the termination of

* Zool. Anzeig., ix. (1886) pp. 591–7.
† Report Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 1097–8.

the body in a wide membranous expansion bearing four branchial processes. This last is highly contractile, owing to the presence of numerous stellate muscle-cells between the respiratory and epidermal walls; the blood-vessels are here also much modified, the abdominal vessel dividing at its termination into two branches, which run round the area, giving off one looped branch to each branchial process, and also branches which cross the area obliquely. There are never more than four processes arising from the floor of the area, but there may be also two smaller marginal processes. Eight species are enumerated, and the characters of their respiratory processes distinguished and indicated.

Budding in Oligochæta.*—Prof. A. G. Bourne finds that there are variations in the mode of budding in different genera and species of Oligochæta. He has made an exact study of *Nais* (*Stylaria*) *proboscidea*, and finds that when budding is about to commence there is a slight thickening of one of the septa which separate the cœlomic segments. This thickening increases, the body-wall in the region thickens, and an actual budding region is formed. This new region elongates and presents a solid appearance. The alimentary canal grows and is at first distinguished by its lighter colour. The budding region divides into two; the anterior portion developes numerous setæ, and gives rise to an indefinite number of segments which form the tail of the old worm; the posterior portion developes four pairs of ventral setæ. The characteristic proboscis being developed, the two individuals separate. The budding region usually appears between the twenty-fifth and twenty-sixth segments, so that the twenty-sixth segment of the parent becomes the fifth segment of the daughter, the four anterior segments never presenting dorsal setæ, and being in all individuals modified (or cephalized).

Excretory and Generative Organs of Priapulidæ.†—Dr. H. Schauinsland describes the as yet unknown excretory or generative organs of the Priapulidæ. The tubes that open with the anus are primitively the efferent parts of the excretory organ, and they only secondarily take on a generative function. From these tubes small canals extend into the cœlom; these soon branch and form the excretory apparatus. The terminal organs or true secreting parts consist of small pyriform cells, each of which has one extremely long flagellum which projects into the excretory canaliculus, and keeps up an active motion; in its region the canaliculi are non-ciliated, but on the rest of their course the cells that line them have a few short cilia. The excretory cells may be compared with those of Platyhelminthes. When the production of ova and sperm commences the two tubes begin first to form small folds, which grow into the attaching mesentery; from these there arise small tubes which in the female are generally unbranched, but in the male are a good deal ramified.

The generative products are developed from the epithelium of these tubes; the young cells, as soon as they are larger than the other epithelial cells, appear on the outer surface of the tube; as soon as they are mature they gradually return, and fall free into the lumen. The spermatozoa have an altogether similar history; they are at first distinguished from the neighbouring cells by the size of their nuclei. These products pass from the lumen directly to the exterior, and do not, therefore, as in other Gephyrea, first fall into the cœlom. In old animals the structure of the gonads is very complicated, owing to the conversion of the tubes into what look like flat lamellæ. The structure of the excretory organs and the

* Rep. Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 1096–7.
† Zool. Anzeig., ix. (1886) pp. 574–7.

mode of formation of the genital products are in the Priapulidæ so different from what is seen in other Gephyrea, that they afford another reason for that rearrangement of the system of the class to which Hatschek has already directed attention.

Lymphatic System in Enchytræidæ.*—Dr. W. Michaelsen corroborates and extends what he has previously noted in the Chætopod Enchytræidæ as to the existence of vessels connecting the gut and the circulatory system. After giving diagnoses of *Buchholzia* and *Enchytræus tenuis*, he describes in detail the position of these connecting vessels. Between the intestinal epithelium and the circular muscles there is a blood-sinus divided into numerous intertwining and communicating canals. Between certain segments a system of fine canals can be detected penetrating the epithelium-cells—these are the chyle-vessels. The chyle passes into these, and thence by osmosis into the blood. Dr. Michaelsen describes analogous arrangements in various forms. The appendage to the gut in *Brada* is regarded as morphologically between the appendage in *Buchholzia appendiculata* and the "heart-body" of many Annelids. The former is lymphatic, the latter probably effects the purification of the blood, while the appendage of *Brada* is perhaps also physiologically between the two, serving both for the absorption of the nutritive juice and the separation of the useless components.

Oogenesis in Ascaris.†—The phenomena of maturation in the ova of *Ascaris megalocephala*, so recently investigated by Nussbaum and by van Beneden, have now been observed by Prof. J. B. Carnoy. As the two former authorities differed, so Carnoy from both. The memoir is very handsomely got up—quite an *édition de luxe*, with its large print, wide margins, tabular summaries, and magnificent plates.

Carnoy's principal observations are thus summed up. In *Ascaris megalocephala*, (*a*) the typical nuclein element divides early into eight approximately equal stumps, which separate immediately into two groups of four, disposed laterally with respect to the axis of the future spindle, and forming the two germinal spots. (*b*) These are motionless during subsequent development and maturation. (*c*) At the entrance of the sperm, sometimes sooner, sometimes later, the germinal vesicle begins to move, and bursts its membrane; a karyokinetic figure appears with a halved spindle and with associated asters of various orders and degrees of complexity. The germinal spots remain equatorially, each on half a spindle, without change or division. (*d*) At the surface the figure dislocates and divides, or remains intact, and disappears into ordinary cytoplasm, in which the two germinal spots remain still intact. (*e*) Between the latter a new spindle appears, the spindle of separation, and at the same time the small rods often arrange themselves in a row. (*f*) Soon one of the spots is expelled with a variable portion of protoplasm, but without undergoing change; the other half remains also as it was. (*g*) From the latter a second figure arises, separated into two groups just as at first. These lie equatorially, and do not undergo fragmentation or any change. (*h*) The new figures are exactly like the old, halved up the middle, much elongated, and rich in asters. They too are resolved into ordinary cytoplasm. A new separation spindle appears, and one of the two groups is expelled. The survivor forms, of course, the final nucleus, and becomes provided with caryoplasma and a membrane. The memoir also contains a large number of more general notes on the problem of division.

* Arch. f. Mikr. Anat., xxviii. (1886) pp. 292–304 (1 pl.).
† La Cellule, ii. (1886) pp. 1–77 (4 pls.).

Nematoid Parasite on Sugar-cane.*— Dr. A. Treub has lately discovered on the roots of the sugar-cane in Java a nematoid parasite which he calls *Heterodera javanica.* Its general habit is analogous to that of *Anguillula tritici*, or of *Heterodera schachtii.* The small females penetrate into the main root through some cleft, or perhaps from the growing point. They settle down at some point where a secondary root is given off. This region is externally marked by a knot-like swelling due to the increased growth of surrounding cells. Treub does not state to what extent the parasite is hurtful.

Cysticercus cellulosæ in Brain of Man.†—The exception to the ordinary life-history of Cestodes, as expressed in the occurrence of *Tænia solium* and *Cysticercus cellulosæ* within the same human form, has always provoked some surprise. The experiments of Redon and the close anatomical resemblances have led Leuckart and other authorities to regard it as certain that the cystic form found in the brain of man was really the *Cysticercus cellulosæ* or the early stage of *Tænia solium*, and to explain its abnormal occurrence as due to self-infection in some form or other.

M. Adolphe Hannover questions this explanation and the postulate on which it is based. The simultaneous occurrence, if the result of self-infection, ought to be much more frequent than it is. The unusual position of the *Cysticercus*, when compared with that exhibited by those in other animals, e.g. pig, is also noteworthy. So, too, the peculiarities of form, and the extraordinary size, suggest to him something more than a mere physiological difference of environment. He has subjected the two forms of *Cysticercus* in man and in pig to a careful and detailed scrutiny, and though none of the differences chronicled are in themselves very noteworthy, the combined differences are suggestive, if not of M. Hannover's theory, then of the modifications of the same form in different surroundings.

Bothriocephalus latus in Belgium.‡—Prof. E. van Beneden has a careful discussion of the question of the existence in Belgium of this large human tapeworm; till lately, though found in Holland, it seems not to have attacked the Belgians. The author states that Prof. Leuckart thinks that railways, and the facility of communication which is their result, will lead to a gradual dissemination of parasites.

Scolex polymorphus.§—Dr. F. Zschokke considers that *Scolex polymorphus*, which is found in the intestine of various species of *Lophius*, *Gobius*, and other fishes, is the larva of some species of *Calliobothrum.* It has the rudiments of the four accessory suckers, and the central sucker; the muscles for moving the hooklets are present, and the excretory system is on the same type as in this form.

The author considers that Wagener's division of the scolices, according to the mono-, bi-, and tri-locular condition of the suckers, is unnatural; they are merely various stages in the development of one and the same larva.

The Diplostomidæ.‖—M. J. Poirier has examined *Diplostomum siamense*, *D. pseudostomum*, and *Polycotyle ornata* of W. Suhm (not Suhn as printed by the author). He finds that the genital orifices are not separately placed on the ventral surface of the lanceolate region of the body, but that they open into a common cloaca at the hinder end; the orifice ordinarily

* Naturforscher, xix. (1886) p. 401.
† Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 508–14.
‡ Bull. Acad. R. Sci. Belg., lv. (1886) pp. 265–80.
§ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 354–6.
‖ Arch. Zool. Expér. et Gén., iv. (1886) pp. 327–46 (3 pls.).

considered as that of the male duct is the opening of the sucker, and that which has been taken for the female orifice is that of a large cavity which is in relation to a large glandular mass. The digestive apparatus extends through the whole of the posterior cylindrical region, and the excretory apparatus is well developed. Save for the fact that the suckers are dorsal, *Polycotyle ornata* has all the characters of a Diplostomid, and should be placed in the family of the Diplostomidæ, and not, as Suhm thought, near the Polystomidæ.

Nemerteans of Roscoff.*—In August 1885 M. F. Chapuis collected at Roscoff thirty-five species of Nemerteans, among which *Cephalothrix viridis*, *Polia cæca*, *Lineus variegatus*, *Cerebratulus modestus* are new species; there is also a new variety of *Cerebratulus fasciatus* with the sides and lower surface white. *Tetrastemma diadema* differs in colour from the specimens described by Hubrecht.

Ova and Development of Rotatoria.†—Herr G. Tessin commences his essay with some notes on the female generative apparatus, and the formation and maturation of the ova, in which the observations of Plate are discussed and criticized; the somewhat irregular segmentation is next described, and gastrulation is found to be epibolic. The mesoderm apparently, but not really, arises from the ectoderm, and commences to be formed at the anterior end; the observations of Zacharias are traversed. The ectodermal cells are for a long time remarkable for the difference between the dorsal and primitively ventral cells; the cephalic region is exclusively formed of the small primitively dorsal cells, while the ectoderm of the trunk and tail is derived from three ventral ectodermal cells; what Salensky regarded as the central organ of the nervous system really gives rise to the pharynx and the wheel-organ. The first part of the nervous system to appear is the eye-spot, which marks the position of the brain. The endoderm has early the appearance of one small posterior and two larger anterior cells.

With regard to the systematic position of the Rotatoria, as to which so many very different propositions have been maintained, Herr Tessin remarks that they all agree in considering the adult organism to the exclusion of its mode of development. The peculiar mode of segmentation, and the fact that a part of the ectoderm long remains connected with the endoderm, while the mesoderm is early separated from the latter and connected with the ectoderm, appears to be a secondary change; the difference between them and other Bilateralia in the mode of origin of the mesoderm is only apparent. Gastrulation results in the appearance of a hypogastric bilateral form; the prostoma does not pass to one pole of the egg, but to what will be the ventral surface, and it marks the place of the definite mouth, which in all hypogastric Bilateralia arises either directly or indirectly from the prostoma. The further characteristic—of a transverse axis—is also developed. It seems, indeed, to be certain that the Rotatoria must be regarded as true hypogastric Bilateralia.

With regard to their relationship to the Annelida—a view which has been based by Hatschek on his well-known trochophore stage—the author objects to the homology instituted between the oral circlets of cilia in Rotatoria and the preoral and postoral ciliated circlets of the trochophore. When the development of the wheel-organ is studied, and its origin from an anterior ectodermic invagination (just like the tentacles of the Bryozoa)

* Arch. Zool. Expér. et Gén., iv. (1886) pp. xxi.–iv.
† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 273–302 (2 pls.).

is borne in mind, it is impossible to homologize it with the circlets of worms. In the latter the preoral circlet surrounds the frontal area, and within it the brain arises; but in the Rotatoria the brain always lies outside the wheel-organ, which does not inclose the frontal area.

The lobate structures which are found round the mouth of all rotatorian larvæ appear to the author to be remnants of the largely developed lobate appendages of turbellarian larvæ.

Although there are close anatomical resemblances between the excretory organs of worms and Rotifers, they must not be supposed to have arisen in the latter from the former; the point of union between Annelids and Rotifers must be sought for deeper down in the scale of animal organization—in the Turbellaria.

The mode of origin of the mesoderm opposes the view that Annelids and Rotatoria are closely allied, for in the latter it arises at the anterior lip of the prostoma, and in all the former at the hinder end of the body; the mesoderm of Rotatoria can only have been developed from a not yet definitely localized mode of formation of the mesoderm, such as obtains among the Turbellaria.

With regard to an affinity between the Rotatoria and the Crustacea, the mode of origin of the mesoderm offers some support; the reduction of the postabdomen is another point of similarity, as is also the dorsal position of the anus. The jointing and forking of the same region recalls the Copepoda, and seems to be an important characteristic. The absence of a ventral medulla is against crustacean as well as annelidan affinities.

The author thinks he has justified the removal of the Rotatoria from the "class of worms," and ascribes to them a position intermediate between the lower worms and the lower crustaceans. In the system they must form a special division between Vermes and Crustacea.

Natural History of Orthonectida.*—M. R. Köhler finds that *Rhopalura* is found rather more abundantly in those Ophiurids which dwell among the tubes of *Serpula Philippii* than in those which live quite freely. Parasites are rarely found in specimens that have been in glasses for some days. Both males and females were frequently found in the same Ophiurid, and the males are always more abundant than the females. Contrary to the observations of Julin, the author failed to find that the season had any modifying influence on the proportion of the sexes.

Two New Species of Balanoglossus.†—Prof. A. F. Marion gives a detailed account of the two new species of *Balanoglossus*, whose characters were indicated in a note already referred to in this Journal.‡ Information is now given as to the results of an examination of transverse sections, as to which the author is very detailed, but he abstains from any generalizations.

Cœlenterata.

Polypes turned outside in.§—Herr M. Nussbaum gives an account of experiments on *Hydra*, in which he tested the often-repeated assertion, based on the authority of Trembley, that in a *Hydra* turned outside in, ectoderm became endoderm, and endoderm ectoderm, and all was again in *statu quo*. This is not the case. After a time, according to Nussbaum,

* Comptes Rendus, ciii. (1886) pp. 608–10.
† Arch. Zool. Expér. et Gén., iv. (1886) pp. 305–26 (2 pls.).
‡ See this Journal, 1886, p. 252.
§ Biol. Centralbl., vi. (1886) pp. 570–2. (Ber. 59 Versamml. Deutsch. Naturf. u. Aertze, Berlin, 1886).

an outer ectoderm is, indeed, recognizable, but this originates, not by the modification of the everted ectoderm, but as a growth from the tentacles and basal pore.

His further experiments led him to these three conclusions:—(1) That the nature of tissues is constant, ectoderm is always ectoderm, and cannot become endoderm; (2) that for reconstruction of the whole from a part, that part must contain representative portions of all three layers; (3) that the artificial division of Protozoa and Polypes lends support to the theory of heredity suggested by Jäger, clearly enunciated by Nussbaum, and recently developed by Weismann—the theory of the continuity of the germinal protoplasm.

Structure and Development of Siphonophora.*—Prof. C. Chun finds that the most common Siphonophore of the Mediterranean has never been properly recognized; he gives it the name of *Diphyes subtilis;* its *Eudoxia*-stage was known to Will, who applied to it the name of *Ersæa elongata.* The author gives a table showing the relation of the *Eudoxia*-stage to five Mediterranean Calycophorids:—

1. *Cuboides vitreus* (?) Quoy and Gaimard *Eudoxia cuboides* Leuckart	*Abyla pentagona* Eschscholtz.
2. *Eudoxia messanensis* Gegenbaur .. .. *E. campanula* Leuckart	*Diphyes acuminata* Leuckart.
3. *Ersæa truncata* Will .. .. *Diplophysa inermis* Gegenbaur	*Monophyes gracilis* Claus.
4. *Ersæa pyramidalis* Will .. .. .. *Eudoxia eschscholtzii* Busch	*Muggiæa Kochii* Chun.
5. *Ersæa elongata* Will	*Diphyes subtilis* Chun.

The author doubts the production of *Eudoxia*-stages in any other of the well-known Diphyids of the Mediterranean.

Structure of Eleutheria.† — Dr. C. Hartlaub has a preliminary notice on this small creeping Cladonemid; it has a bell-cavity of the normal width, which is bounded below by a broad velum. Below the zone of tentacles the side wall of the cavity is formed by a well-developed urticating ridge. The brood-cavity is placed on the dorsal side of the animal, and is not the homologue of the canal of the manubrium of the medusa bud, for it has no communication with the gastric cavity; it is invested by a special epithelium, and is connected with the bell-cavity by six interradial canals. It is hermaphrodite, and its sexual cells are developed from the epithelium of the brood-cavity, the female cells ventrally, and the male dorsally.

The bell, in the ordinary sense of the word, is rudimentary, the radial canals being extraordinarily short, and the peripheral part very delicate. The urticating ridge reminds us of the same parts in the Trachynemidæ and Geryonidæ, but is distinguished by the fact that it consists of an inner layer which carries the stinging cells, and an investing epithelium, which, to guess from the figures given by the Hertwigs, is wanting in the first-mentioned forms. The velum, the presence of which has been hitherto denied, is very broad, and may almost completely close the bell-cavity; the bell-wall does not serve as a propelling organ, but for a support and brood pouch.

The author was able to convince himself of the hermaphrodite nature of this remarkable medusoid by means of a series of sections made on fortunately selected examples; only twelve per cent. were found to be

* SB. Preuss. Akad. Wiss., 1886, pp. 681–8. † Zool. Anzeig., ix. (1886) pp. 707–11.

hermaphrodite, the rest having female cells only. As some large forms were found without brood pouches, and a number of very small ones with the pouch well developed, the period of reproduction must either vary with individuals, or must be periodic.

Gastroblasta Raffaelei.*—Dr. A. Lang describes a remarkable craspedote medusa which he observed at Naples; almost all the individuals examined had more than one stomach and a varying number of apparently irregularly-arranged tentacles and radial canals; one large individual had nine gastric tubes; so that it appeared to him that he had before him a colony of medusæ formed by a kind of incomplete division.

The example just mentioned had its greatest disc-diameter 4, and its smallest 2·7 mm.; all the other examples were much smaller. The form taken for description had the disc slightly curved, the gelatinous substance poorly developed, the velum pretty broad and powerful. The outer circumference of the disc is not circular, but somewhat ellipsoidal; at the margin tentacles and tentacle-buds were found at various stages of development. Between them were ten auditory vesicles formed on the leptomedusan type. Of the four gastric tubes not one is central; each gave off a radial canal, which opened into the well-developed circular canal.

A study of the tentacles showed that the margin of the umbrella was divided by the four that were oldest into four quadrants of unequal size; the relative positions of the various tentacles is exactly stated. The ten auditory vesicles were found to be of various ages, and seem to appear much later than the tentacles; similarly the four radial canals were of different ages. The tentacles are hollow, and much thickened at their base; the urticating capsules are arranged in more or less distinct rings; in structure the tentacles resemble those of *Eucope* and *Phialidium*. The gastric tubes are unstalked, tubular, and capable of considerable enlargement; each is produced into a large quadrangular oval disc, which is very contractile; the wall of the stomach is very thick, and of the disc very thin. The constancy in the number of four gastric processes is the sole anatomical characteristic which points to the primitive quadriradiate structure of the Medusæ. New gastric tubes arise as outgrowths of the radial canals which project into the cavity of the subumbrella; and, on superficial examination, they may be mistaken for gonads.

Division is one of the means by which this remarkable form reproduces itself, and the plane of division is at right angles to the connecting vessel between the oldest and next oldest stomach, and is also at right angles to the longest diameter of the disc; the organs in each half correspond exactly in number, arrangement, and age-series, allowing, of course, for the fact that each half cannot have exactly the same parts; that is, if the right half be called *A*, and the left *B*, the oldest tentacle (*t*) of the mother becomes the oldest tentacle of *A*, the second oldest the oldest of *B*, the third oldest of the mother the second oldest of *A*, and so on. It is, in fact, possible to say of either to which half of the mother it corresponds.

The author next describes the metamorphosis of the daughter animal which arose by division; if the starting stage be that of the left half of the dividing medusa, the second stage is marked by the development of fresh tentacles and a new radial canal; in the third there is, *inter alia*, a new stomach developed, and in the fourth a fresh mouth. The result of all this is that the daughter is now exactly like the mother. There may be now a fresh fissure, in which the same phenomena as before are seen, or there may be further budding; in the latter case there may come to be 26 well-

* Jenaisch. Zeitschr. f. Naturwiss., xix. (1886) pp. 735–63 (2 pls.).

developed tentacles, about 17 rudiments of tentacles, 20 radial and centripetal canals, 9 completely developed and 7 rudimentary stomachs. Observations were made on the mode and order of development of the gonads; even the sexual forms may divide by fission.

The peculiarities of this remarkable form may be thus summed up:—1. Existence of several gastric tubes. 2. Absence of a central stomach. 3. The budding, in obedience to quite definite laws, of new tentacles, marginal vesicles, radial canals, gastric tubes, and gonads on the radial canal. 4. Successive and regular right-angled divisions. 5. Variations in the age and size of homologous organs, and the complete absence of a radiate structure. 6. Adradial position of the tentacles, and interradial position of the marginal vesicles.

In conclusion, the author offers some speculations on the mode of origin of this form, into the details of which we have not space to follow him. If the Medusa had radiate larvæ like *Eucope*, which reproduced by successive rectangular divisions, in the way described by Davidoff, the series would necessarily give rise to irregular stages; Dr. Lang thinks that Davidoff's form was not *Phialidium variabile*, but the first stage of *Gastroblasta*. The adult Medusa is the result of continued budding, cotemporaneous with continuous but incomplete divisions, just as in the animal colonies of certain stone-corals. Many points in the new form call to mind *Porpita* or *Velella* among the Siphonophora; and it is to be remembered that Prof. Häckel ascribes a different phyletic origin from the other Siphonophores to the two genera just named. *Gastroblasta timida* from the Red Sea, described by Keller in 1883, has many points of resemblance to the new species.

New Sessile Medusa.*—Prof. C. Vogt discovered off the coast of Sardinia, at a depth of 50 fathoms, a small organism attached to the stem of a *Gorgonia*. This he finds to be a medusa, to which he gives the name *Lipkea Ruspoliana*.

It has the form of a flat soup-tureen; the umbrella is drawn out into eight short arms, into which the archenteron is continued; the convex surface of the umbrella is scooped out so as to form a sort of sucker, by which the Medusa remains fixed. The mouth is situated on a short four-sided manubrium, and leads into the archenteron, which is divided by four septa into as many stomachal pouches. There is no marginal canal. There are four pits in the subumbrellar surface, resembling the subgenital pits of the Acraspedota, but no genital organs were found; bundles of gastric filaments are present. The jelly is firm, as in the Craspedota, and only a few fibres (? muscular) are present near the sucker; but there is a circular band of muscular fibres round the margin of the umbrella. On the subumbrellar surface are numerous glands, containing rounded bodies, like young nematocysts. True nematocysts are present only on the convex surface; no marginal sense-organs were found.

Lipkea is, then, a new type of Häckel's Stauromedusæ, differing in certain points both from the Lucernaridæ and from Tesseridæ. Vogt defines the family as "Stauromedusæ with eight hollow arms; the bell fixed by a sucker; a continuous circular muscle; no tentacles, but exhibiting a considerable development of mucous glands." The author considers this new form as supporting his theory that the Medusæ are derived from forms primitively free-swimming, but in the development of which are intercalated degenerate, sessile, hydriform persons.

* Arch. Sci. Phys. et Nat., xvi. (1886) pp. 356–62.

Porifera.

Vosmaer's Porifera.* — The volume on sponges, by Dr. G. C. J. Vosmaer, in Bronn's 'Klassen und Ordnungen,' has just been completed in sixteen parts. The author is to be congratulated on the result of his labours. The defects, in regard to which he asks charitable criticism in his almost too apologetic preface, seem rather due to the nature of the subject and limit of space than to the author. The last five parts complete the systematic portion, and discuss in a perhaps slightly too compressed manner the ontogeny, physiology, distribution, and relationships of the group. Herr Vosmaer may be assured of the gratitude of every non-specialist who has attempted the identification of sponge forms.

Spongilla glomerata.†—Herr F. C. Noll describes a new species of fresh-water sponge from the island of Rügen, which differs in some important points from forms hitherto described. The gemmules were extraordinarily large, and are called gemmulæ balls by the author; they may be spherical, egg-shaped, or irregular in form, and are really masses of gemmules, six to fifteen being inclosed in a common investment. They give rise to the idea of a further division having gone on after the formation of extraordinarily large rudiments. On the surface of the balls there are a number of infundibular orifices, each of which is the pore of a gemmule, and all of which are so closely attached to the inner surface of the wall that when the ball is broken a gemmule remains attached to every piece of the investment.

The author describes the structure of the covering layer, and compares its constituents with those of allied species.

Herr F. Vejdovsky ‡ points out that this new species is nothing more than the widely distributed *S. fragilis* of Leidy, the synonymy and literary history of which are given in detail.

Fresh-water Sponges of Galicia.§—Herr A. Wierzejski has monographed the fresh-water sponges of Galicia, and considerably reduced the number of species. Within the genus *Spongilla* he recognizes only five subgenera, with five species. The multitudinous synonyms are carefully noted, and the following nomenclature proposed—(1) *Euspongilla lacustris* Vejd. (*Spongilla* auct.), (2) *Spongilla fragilis* (Leidy), (3) *Ephydatia fluviatilis* Vejd., (4) *Meyenia Mülleri* Wierz., (5) *Trochospongilla erinaceus* Vejd.

South Australian Sponges.‖—Mr. H. J. Carter continues and concludes his supplementary notes on the sponges collected in South Australia by Mr. J. B. Wilson; the four orders, Psammonemata, Rhaphidonemata, Echinonemata, and Holorhaphidota, being here dealt with. It is stated that the specimens have been deposited in the British Museum.

Protozoa.

Adoral Ciliated Organ of Infusoria.¶—The adoral ciliated organ of heterotrichous and hypotrichous Infusoria has been variously interpreted, by Stein as large cilia in grooves, by Sterki, Maupas, and Entz as skin plates. Prof. K. Möbius shows that the organ in question consists of

* Bronn's 'Klassen u. Ordnungen des Thier-Reichs, ii. Porifera,' 1887, Nos. 12–16, pp. i.–xii., 369–496, pls. xxvi.–xxxiv.

† Zool. Anzeig., ix. (1886) pp. 682–4.

‡ Tom. cit., pp. 713–5.

§ Ann. Acad. Sci. Cracovie, 1885. Cf. Arch. Slav. de Biol., ii. (1886) pp. 37–40.

‖ Ann. and Mag. Nat. Hist., xviii. (1886) pp. 369–79; 445–66 (1 pl.).

¶ Biol. Centralbl., vi. (1886) pp. 539–40 (Ber. 58 Versamml. Deutsch. Naturf. u. Aertze, Berlin, 1886).

ciliated combs or pectinellæ, which are composed of numerous fine cilia, whose connected basal portions form the transverse ridges of the ciliated organ. Prof. Möbius also describes the multiplication of *Freia ampulla* Müll. by unequal longitudinal division.

Contractile Vacuoles of Infusoria.*—Herr S. Fischer has investigated the contractile vacuoles of *Aspidisca lynceus* and *Paramæcium aurelia.* The former infusorian had three pulsating vacuoles; the largest to the right of the mouth with regular pulsations; the second of smaller size and posterior position, with pulsations alternating with those of the former; while the third and smallest exhibited irregular and less frequent pulsations. At the maximum diastole of the largest a thin drop appears close beside it, which increases gradually during the systole, and becomes the new vacuole. In *Paramæcium* the vacuole at its maximum extension is surrounded by a system of delicate canals, slightly swollen at a certain distance from the vacuole. During the systole the swollen extremities gradually come into contact to form a new vacuole. There is thus no definite membrane round the vacuoles. The contents were seen in *Aspidisca* to be expelled to the exterior. The pulsations are accelerated in deficient aeration of the water.

Bursaria truncatella.†—Herr A. Schuberg has studied *Bursaria truncatella* with special reference to protoplasmic structures. For the purposes of fixation he made use of the vapour of osmic acid, or, in preference, of Flemming's mixture of chromic, osmic, and acetic acid, especially as modified by Fol. After washing in water, and being placed in 1 per cent. osmic acid till they were slightly browned, the infusorians were ready for clearing up and preservation in Canada balsam. Sections were made after the object had been completely blackened by osmic acid, and further stained by strong Böhmer's hæmatoxylin.

The author commences by pointing out differences from the usually received accounts; he was not able to detect a complete symmetry, the greatest thickness of the hinder end of the body being somewhat towards the left side; the anterior end is always oblique. There appears to be some variability in the peristome; this portion arises from a straight peristome which lies quite free on the surface, undergoes a gradual insinking and a correlated spiral inrolling of the adoral zone; with this there may be connected that development of a septum which is due to the greater growth of some parts. Directly connected with the peristomial cavity is a space, the true relations of which seem to have escaped all previous observers. Though the form of the peristome varies considerably, it is always deepest on the right side of the animal, and its dorsal wall is hollowed out on the ventral aspect; towards the base of this cavity a septum becomes developed, and separates off a septal space; this septum is the only part of the peristome that carries cilia.

The origin of this arrangement is explained thus: As, cotemporaneously with the peristomial cavity, the hinder edge of the peristome grows forward in such a way that a flattened bridge extends from the left peristomial margin over the right margin, a cavity must be formed which is connected with the peristomial cavity at its hinder end, as well as along its left side. The boundary of this septal space on the side of the peristomial cavity, which are now only connected by a relative narrow cleft, is naturally formed by the primitively right peristomial margin, beset with cilia. Since the growth of the hinder peristomial margin did not take place along the right margin, but in a line somewhat more to the right, the

* Arch. Slav. de Biol., ii. (1886) pp. 288–9, from Wszechswiat, 1885.
† Morphol. Jahrb., xii. (1886) pp. 307–65 (2 pls.).

primitively free right edge came to lie in a cavity which it divides into two. The septum, therefore, which separates the peristomial cavity from the septal space is nothing more than the hindermost part of the primitively right peristomial margin, which by a special process of growth has become inclosed in the interior of the body. This history explains the presence of cilia on it.

With regard to the finer structural relations of this cell, the author compares the endoplasm to that of *Noctiluca miliaris*, for in both the large protoplasmic strands exhibit a fine plexiform structure. The ectoplasm is not of the ordinary type, but the outer layer is specially differentiated, and ought to be distinguished from what is seen in Rhizopods and many Infusoria. Attention is directed to its radiate structure, and it is shown that this has nothing to do with the presence of cilia. It is observed that in all the striations of the peristome the separate bands are connected with one another by transverse bars of protoplasm, which appear to lie deep. In prepared specimens it is possible to see on either side of a peristomial band a series of fine dots; if the focus be altered we get an optic section of a membranella, which is not simple, but is composed of two more or less approximated lines; if the focus be again altered, the fibrillated margin of the membranella may be seen. The fine dots appear to be the sections of the fine bands, and these perhaps are to be regarded as the primitive elements of the membranellæ. Further observations are necessary to determine whether we may regard the membranellæ of *Bursaria* as being made up of two rows of cilia. The transverse bands seen in the peristome are the points of attachment of the membranellæ.

Morphologically, the peristomial and the connected transverse bands are nothing more than specially thickened parts of the ectoplasm, which appear to owe their origin to the connection with the system of striæ in the peristome; so far as the author knows, nothing like them has been found in any other infusorian, and their function still remains to be discovered.

Food Habit of Petalomonas.*—Dr. A. C. Stokes believes that the flagellum in *Petalomonas carinata* arises from the bottom of the deep oral aperture. The animal feeds on bacilli and spirilla; when in the neighbourhood of masses of these bacteria, it comes to rest; the flagellum, with the exception of the free end, is motionless. The bacteria, either by their own movement, or by that of the free-end of the flagellum, knock against the motionless portion, and glide down into the oral aperture. From this they may escape, unless they touch the slightly oblique posterior wall of the oral pit when they are engulfed in the protoplasm. The bacteria are frequently seen to return again and again to the pit after their escape.

The author asks "What is the special attraction that leads them to congregate in the pit, and why should the bacteria allow themselves to be thus engulfed?" The latter probably is due to the oblique plane at the bottom of the pit.

Gymnodinium polyphemus.†—The specific name is given to this flagellate protozoon by M. Pouchet, from the fact that it possesses an eye of considerable complexity.

The eye consists of a transparent, highly refracting lens, rounded at its free extremity, which is always directed forwards. The inner surface is imbedded in a hemispherical cap-like mass of pigment, which represents a choroid. In some of the forms this pigment is red, in others black. In young forms, even when still encysted or undergoing fission, this lens is

* Sci.-Gossip, 1886, pp. 273–4 (1 fig.). † Comptes Rendus, ciii. (1886) pp. 801–3.

formed at first of six to eight refringent globules, which fuse with one another to form the single lens of the full-grown individual. The choroid, also, results from a concentration of pigment-granules, which are at first scattered.

New Foraminifer.*—Prof. H. Blanc describes a new Foraminifer, dredged in the Lake of Geneva, from a depth of 120–200 metres. He names it provisionally *Gromia Brunneri*, but thinks that it will probably deserve to form a new type of this genus. It is of large size, from 0·3 mm. to 1·0 mm.; it varies from flask-shaped to globular, and has a single opening. The shell, slightly lemon-yellow in colour, is formed of fine particles, probably siliceous, glued together. The protoplasm contains a single nucleus and several vacuoles; it covers the shell and forms a network similar to that of other species of *Gromia*.

Colonial Radiolarians.†—The thirteenth volume of the Monographs of the Naples Zoological Station contains an account of the Sphærozoa or colonial Radiolarians by Dr. Karl Brandt. The monograph treats of these forms under the four heads (1) Morphology, (2) Biology, (3) Reproduction and Development, and (4) Systematic, and in its exhaustive historical survey and independent investigation, as well as in its wealth of illustration, well supports the character of the splendid series. From the nature of the group the number of new results is not of course very great.

I. *Morphology.*—After a general introduction and historical sketch of the progress of our knowledge of the Sphærozoa, Dr. Brandt proceeds to a morphological survey. (1) *The protoplasm.* The central protoplasm differs physically and chemically from the peripheral. The latter consists of pseudopodia and assimilative protoplasm darkened by superosmic acid. The central substance is not so darkened, and this is but an index to other differences. (*a*) *The central substance* is divisible into two masses; the inner surrounding the oil-globules, the nucleus-containing vacuoles in spore-formation, as also pigment granules and large crystals; the outer surrounding the nuclei. (*b*) *The cortical substance* often contains abundant granules while the central contains none, or *vice versâ.* It consists, as noted above, of assimilative and of pseudopodic protoplasm. (2) *The nuclei.* In the vegetative period the nuclei are homogeneous. Those of the isospores are doubly refractive, which probably expresses a very fine differentiation. Those of the anisospores and of the "extracapsular bodies" formed in the young vegetative colonies are further differentiated. The phenomena of nuclear division in the anisospores of Collosphæridæ appeared to be very simple. (3) *The central-capsule membrane* is regarded as homologous with the cell-wall. In some vegetative colonies it appeared to be absent, but even then the central and cortical protoplasms were not exactly continuous. Pore-canals were observed in *Collosphæra huxleyi.* The membrane cannot be detected during or after the escape of the swarm-spores. (4) *The oil-globules* appear early and remain till the close of the vegetative life. In very young colonies and in the swarm-spores they are represented only by fine granules. Only in one form is there more than one large globule in each individual. The author doubts the existence of an albuminoid basis, and regards the inclosed substance as fat. (5) *The crystals,* which are present only during the reproductive period, are distinguished into large forms, which do not pass into the spores, and small forms which do. They are never truly crystalline. The large forms are excretions, the small

* Arch. Sci. Phys. et Nat., xvi. (1886) pp. 362–6.

† Fauna u. Flora des Golfes v. Neapel, Monographie, xiii. (1885) viii. and 276 pp. and 8 pls.

consist of an organic substance and are reserve material. (6) *The pigment* also occurs in the reproducing forms, is never diffuse but always granular, varies from blue to reddish violet, and appears simultaneously with the crystals. They are excretory masses, formed during the spore-building, and are left behind. Their chemical reactions are noted in detail. (7) *The connecting jelly-like substance* is normally present and is of great importance in keeping the colony together. It increases throughout the vegetative period both in mass and consistence, and becomes sometimes almost cartilaginous. It disappears rapidly in confined specimens. After the appearance of the zoospores it also decreases, first slowly and then rapidly. Even in dead spirit specimens some physical properties, e. g. of swelling out again in water, remain. Morphologically this substance is an excretion of the protoplasm. Physiologically, it is essential to the connectedness, protection, hydrostatic and even nutritive functions of the colony. (8) *Vacuoles* are not present in very young colonies. As the jelly-like substance becomes separated from the penetrating fluid, vacuoles are formed, to disappear again as spore-formation begins. They are surrounded by a fine plasmic layer. The variations in form and distribution are noted. The author regards them as entirely comparable to the vacuoles of other Protozoa. (9) *The skeleton.* The presence or absence of a skeleton cannot be regarded as establishing a natural division. In noting the mode of growth Brandt maintains the existence of an organic basis with subsequent silicification. He deprecates the erection of species on the variations of the spicules. (10) *Yellow cells.* These symbions, which Brandt has named *Zooxanthella*, are regarded as perhaps allied to the Peridineæ. The results of assimilation are starch-grains and also granules of different composition. Their presence at different periods, their behaviour when isolated, and other points are then noted. (11) *Individuality of colonies.* Colonies of different species cannot fuse, but colonies of the same species may, and that independent of the developmental stages of the two fusing forms. As Schneider has shown, artificial division is readily practicable. There is more division of labour within the colony than Hertwig allowed. The functions of intra- and extra-capsular protoplasm are quite distinct. The central capsule even, which solely forms the spores, is not homogeneous in its functions.

II. *Biology.*—(1) *Nutrition.* After noting general facts as to food material, Brandt emphasizes the truly nutritive function of the symbiotic algæ, which contribute the results of their assimilation (starch, &c.) to their animal host. The breaking up of these "yellow cells" during swarm-formation is specially noted, and also the changes in the assimilative protoplasm. (2) *Movement.* The plasmic portions being much heavier than sea-water are floated by the vacuoles and by the gallert-substance, which sometimes appear to be lighter than sea-water, and enormously increase the surface. Mechanical and thermal stimuli produce changes which effect sinking and rising. The pseudopodia affect the specific gravity through their influence on the vacuoles. (3) *Occurrence of different forms.* The distribution of ten species is described in detail, and graphically expressed in curves. The principal result shows their varied occurrence at different seasons. (4) *Environment.* (*a*) The Sphærozoa are very sensitive to changes of salinity. (*b*) They are uninfluenced by light. Even extreme illumination does not affect their vertical distribution. The statement of Geddes that Radiolarians move from the light is denied. (*c*) Apart from seasonal changes, alterations of temperature do not appear to have much effect upon these forms. On gradual cooling several forms were observed to sink. Two forms withstood a prolonged cooling to 1°, but exhibited changes

which after 2–3 days led to a reascent. (*d*) Movements in the water due to wind caused the Sphærozoa to sink. The direction of the wind, e. g the sirocco, had a marked influence which is discussed in detail. Certain currents also influenced the distribution to a noteworthy extent. (*e*) Dr. Brandt's observations are on the whole against any periodicity in the development of the Sphærozoa. (5) *The geographical distribution*, the derivation of these forms from the Atlantic, their absence in colder seas, &c., are then discussed. (6) *Phosphorescence.* The Sphærozoa are phosphorescent, but not with great intensity. The central portion alone is illuminated. The oil-globules are regarded as the seat of the process. (7) *Parasites and "Inquilinen."* Colonies of *Myxosphæra cærulea* frequently contained a parasitic amphipod, *Hyperia*, also Copepods, and Appendicylariæ; living diatoms also occurred in young Collozoa.

III. *Development and Reproduction.*—(1) *Division of the colony* seems certainly to occur, but Brandt was not able to observe the mode of formation of Collozoum chains supposed to occur by Häckel and Hertwig. (2) *Division of the individuals* was observed only in young vegetative colonies, and not in the older or in reproductive forms. (3) *Swarm-spore formation.* (*a*) *Isospores.* Hertwig's observations are generally corroborated, the main difference consisting in Brandt's denial of the statement that the whole mother organism is resolved into the spores. The greater part of the cortical substance is left behind and breaks up. The isospores of all Sphærozoa are said to have two flagella. (*b*) *The formation of an isospore* is distinguished from the above by the occurrence of groups of nuclei in the individuals, by the differentiation of the nuclei, and by the distinct macrospore and microspore nuclei. The anisospores differ further in their more or less bean-like shape, in their difference of size, in the character of their nuclei, and in the absence or peculiarity of crystals. The anisospores have much less reserve material than the isospores. The extracapsular changes are essentially similar. The cortical substance again breaks up, the yellow cells persist as before. (*c*) *Alternation of generations.* According to Brandt all the Sphærozoa have the above two modes of reproduction. In seven out of ten species the twofold method has been demonstrated. The Sphærozoa exhibit an alternation of generations as in algæ and fungi. He believes that from the union of the sexually dimorphic anisospores, a fused mass will result which will produce isospores. He has not, however, observed the conjugation of the anisospores. (4) *Extracapsular bodies* only occur in young colonies, which contain a few individuals. They always exhibit a more or less striking resemblance to the incipient stages in the intracapsular formation of anisospores. They arise by budding from the individuals, are refractive and without granules, but often with an oil-globule, usually with a fatty-mass, and always with a nucleus. True extracapsular bodies have not been observed in Collosphæridæ, but in young forms a somewhat similar phenomenon occurs. In some cases these budded bodies are normally modified into anisospores. In other cases they simply become individuals. In Collosphærids this reproduction within the young forms always results in rapid multiplication of the individuals; in Sphærozoa, anisospores sometimes are formed, though it is quite likely that in the latter also the extracapsular bodies may often form individuals. (5) *Development.* Five phases in the life-history are distinguished:—(i.) the swarm-spore, (ii.) the young vegetative phase, (iii.) the young reproductive phase with formation of extracapsular bodies, (iv.) the older vegetative phase, (v.) the older reproductive phase with formation of isospores and anisospores. In the vegetative phases the nuclei are homogeneous and simply refractive; in the reproductive they are dis-

tinctly differentiated or doubly refractive. The different phases are discussed at length, but the problems of length, transition, and conditions are still unsolved. Some notes on the reproductive phenomena in Acanthometridæ are then added.

IV. *Systematic.*—The Sphærozoida are distinguished from the Collosphærida chiefly in these points: in the formation of anisospores in S. the grouped arrangement of the nuclei persists till the spores begin to be formed, while in C. it is of a very short duration; in S. the macro- and micro-spores are formed in the same individual, in C., however, in different individuals; in S. true extracapsular bodies are formed, but these have never been observed in C.; on account of these developmental differences, therefore, the two families are distinguished. Since it is impossible to summarize the systematic portion of the work, it must suffice to note the net result.

SPHÆROZOA.

Fam. I. Sphærozoida.

Collozoum Hkl. Usually without skeleton, occasionally with isolated spicules.

1. *C. inerme* Müll sp.
2. „ *fulvum* n. sp.
3. „ *pelagicum* Hkl.
4. „ *Hertwigii* n. sp.

Sphærozoum Meyen. With siliceous spicules.

5. *Sph. punctatum* Huxl. sp.
6. „ *neapolitanum* Brandt.
7. „ *acuferum* Müll.
8. „ *Hæckeli* n. sp.
9. „ *spinulosum* Müll.

Fam II. Collosphærida.

Myxosphæra n. g. Without skeleton.

10. *Myxosph. cærulea* Hkl. sp.

Collosphæra Müll. With smooth latticed shell.

11. *Collosph. Huxleyi* Müll.

Acrosphæra Hkl. Latticed shell with pointed spines.

12. *Acrosph. spinosa* Hkl.

Siphonosphæra Müll. Latticed shell, in which the principal apertures are drawn out into tubes.

13. *Siphonosph. tubulosa* Müll.
14. „ *tenera* n. sp.

New Opalina.*—Under the name of *Opalina spiculata* Herr N. Warpachowsky describes a new species of *Opalina* which is found abundantly in the cœlom of young earthworms, and is characterized by the presence of a long spicule which lies in the body, and is about two-thirds of its length. It seems to be most closely allied to *O. prolifera* and *O. uncinata.*

Parasites in the Blood of Lizards.†—Prof. B. Danilewsky communicates a further report of his continued studies on blood-parasites. Along with M. A. Chalachnikow he has investigated those of lizards.

Within red blood-corpuscles which exhibited external peculiarities intracellular parasites or *Hæmocytozoa* were found, as in previous cases. Of intracellular forms three types are distinguished—(*a*) a large, quiescent

* Bull. Acad. Imp. Sci. St. Pétersbourg, xxx. (1886) pp. 512–4.
† Arch. Slav. de Biol., i. (1886) pp. 364–96 (2 pls.).

form, very like *Hæmogregarina stepanowi* of the tortoise, (*b*) a smaller, mobile form, and (*c*) a club-shaped form with slight mobility. Two forms were found much less frequently, and these seemed to be phases of (*b*, *c*).

All these cellular parasites are minutely described as regards structure, motion, effects, &c. The results of different reagents are also noted in detail. The simultaneous occurrence of different forms in the same individual, and the existence of several transition forms suggest a close relationship between the different forms. Further, there is a close affinity between the *Hæmatozoa lacertæ* and such Gregarinida as *Hæmogregarina testudinis.* As to the history of the parasites, Danilewsky is not yet able to supply definite information. His results have certainly shown the extensive distribution of such Gregarine forms, and are further of interest, as he notes, in affording favourable opportunity for studying the modifications of cellular life in response to peculiar environmental conditions.

Parasitic Protozoa in Ciona intestinalis.*—The first part of the results of Prof. C. Parona's study of the parasites found in the intestine of this Ascidian deals only with *Urospora Cionæ.* The author does not deal with the organisms to be found on and within the branchial region, or within the cloaca, nor with those numerous forms which settle upon the test of Ascidians, but only with those which are found amongst the contents of the intestine and stomach. These are studied by withdrawing the contents by means of a pipette, and taking every precaution to obtain the contents unmixed with any water from the exterior of the Tunicate. The structure of the Gregarine, which belongs to Schneider's genus *Urospora,* characterized by a set of caudal appendages, and is probably identical with Frenzel's form *Gregarina Cionæ,* is given, together with certain observations on its development.

The best method of preservation the author finds to be osmic acid 1 per cent.; the object is then mounted in glycerin, which drives out the osmic acid. The individuals are well preserved even at the end of three months.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.†

(1) Cell-structure and Protoplasm.

Destruction of the Molecular Structure of Protoplasm.‡—Herr W. Detmer has experimented on the mode in which injurious external agencies cause the death of the cell. For this purpose he found convenient objects in succulent acid organs, such as the leaf and leaf-stalk of *Begonia manicata.*

Chloroform kills the organ completely in about one hour. Coal-gas is much more rapidly destructive than hydrogen, the leaves becoming completely discoloured in the former gas in seven, in the latter in forty-eight hours. Dilute hydrochloric acid or potash causes flaccidity in a very short

* Journ. de Microgr., x. (1886) pp. 496-501 (1 pl.).

† This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ Bot. Ztg., xliv. (1886) pp. 513-24.

time. Exposed to an electrical induction-current, the leaves became somewhat flaccid after fifteen minutes, a brown colour began to show itself in three hours, and in twenty-four hours the destruction was complete. Injection of the intercellular spaces with water hastens the destruction of the tissues. A temperature of 40° C. for a short time appears to have no injurious effect; one of 55° causes death in about two minutes, one of 75° almost instantaneously. The action of various low temperatures is also described in detail.

In all these various cases the author determined that the cause of the death of the tissue was the destruction of the molecular structure of the parietal layer of protoplasm, by which it becomes permeable for the acid cell-contents. These pass out of the cells, partly into the intercellular spaces, and the cells thus lose their turgidity.

Structure of the Cell-wall.*—Herr G. Klebs criticizes Wiesner's recent theory † of the structure of the vegetable cell-wall. He notes especially (1) the absence of any proof that the dermatosomata are organized unit elements and not simply debris particles, and (2) the exceedingly unsatisfactory evidence as to the presence of protoplasm in the cell-wall. He denies the possibility of demonstrating Wiesner's distinction between (*a*) young living cell-walls in which the majority of the dermatosomata consist of living albumen, with numerous plasma strands between, and (*b*) an older dead stage in which the dermatosomata consist of cellulose, and have between them a connective mass also of cellulose. Further, he does not consider Raspail's reaction for albumen as altogether trustworthy.

Multinucleated Cells.‡—In a number of plants examined (*Polygonum Sieboldii*, *Acanthus mollis*, *Podophyllum peltatum*, *Eschscholtzia californica*, *Impatiens noli-me-tangere*, *Dictamnus Fraxinella*, *Linum pyrenaicum*, *Polygonatum multiflorum*) Mr. A. E. Grant found, on making longitudinal sections of the stem and petioles, that the cells of the wood-fibres contained several nuclei, sometimes amounting to as many as ten. These nuclei appeared in general to spring from the division of a single nucleus.

(2) Other Cell-contents.

Chemical Composition of Chlorophyll.§—Herr J. Wollheim gives a preliminary report of his recent researches on the chemical composition of chlorophyll.

Hansen's pure chlorophyll is shown to be impure alkaline chlorophyll. That prepared by Tschirch's method is also unsatisfactory. Herr Wollheim has endeavoured rather to form a pure derivative; but by means of alcoholic ammonia he was also able to obtain a solution of chlorophyll giving a pure spectrum. He points out the objections to the view that Hoppe-Seyler's chlorophyllan and Tschirch's barium-compound are pure substances. He has shown *inter alia* that iron is not an essential component of bodies in the chlorophyll group. His own treatment resulted in obtaining pure phyllocyanin acid, without iron, and free from all ash. He proposes the empirical formula $C_{28}H_{47}N_3O_6$. The spectrum of pure phyllocyanin acid appears to be identical with that of chlorophyllan, and a hydrochloric solution of pure phyllocyanin exhibits a spectrum identical with the alcoholic solution (1) of the author's zinc phyllocyanin (B-chlorophyll of Tschirch) and (2) of

* Biol. Centralbl., vi. (1886) pp. 449–55. † See this Journal, 1886, p. 818.
‡ Trans. Bot. Soc. Edinburgh, xvi. (1885) p. 38.
§ Biol. Centralbl., vi. (1886) pp. 541–2 (Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, Berlin, 1886).

zinc chlorophyllan, and further with that of the leaf, apart from the displacement towards red exhibited in the latter.

Crystalloids in Pithecoctenium clematideum.*—Sig. R. Pirotta has investigated the distribution and nature of the crystalloids in the above-mentioned plant. As to *distribution* (*a*) in the root, they are much more abundant in the adult than in the young form. In the parenchyma of the deep layer of the cortex they occur abundantly, filling up the cells. They are also numerous in the cambium cells, but are absent from the outer woody portion and from the pith. (*b*) They are less frequent in the stem, especially in the young branches and in the pith. (*c*) In the leaves the crystalloids occur abundantly in the cortical parenchyma, but there is no trace of them in the hairs. They are more abundant in the spongy than in the palisade parenchyma, and accompany the bundles in considerable numbers in the parenchyma and soft bast. (*d*) In the tendrils they occur in scattered groups, especially in the cortical parenchyma and in that which accompanies the bundles. (*e*) In the inflorescence there are not a few in the flower-stalk, and especially just at the base of the flower. (*f*) They occur more or less abundantly in all the floral organs, and abundantly in the fruit, decreasing with ripeness. They do not occur in the seed.

These sphærocrystals vary considerably in size and colour. Numerous fine crystalline acicular prisms radiate out from a centre, which corresponds to a kind of solid amorphous nucleus within the cell. The crystalloids form very simple bundles, or compact hemispherical or spherical bodies. They are soluble in the living cell-sap, in boiling alcohol, glycerin, acetic acid, ether, &c, and their various reactions are noted.

The author believes with Hansen that the substance composing the crystalloids is originally dissolved in the sap, from which it is separated in drops, becoming subsequently crystalline. A list of various sphærocrystals is then given, showing their wide and varied occurrence.

(3) Secretions.

Formation of Oxalic Acid in Vegetation.†—MM. M. Berthelot and E. André have selected and examined at various stages of their growth the following plants:—*Rumex acetosa*, *Amaranthus caudatus*, *Chenopodium quinoa*, and *Mesembryanthemum crystallinum*. The juice of the first is always acid, that of the second and third neutral or feebly acid, whilst that of the last is neutral in the early stages of growth, but becomes acid as the plant developes. The plants also differ very considerably in the ratio between the soluble and insoluble oxalates which they contain.

Rumex acetosa.—The seed or dried fruit contains 0·05 per cent. of oxalic acid. In the early stage of growth (June 8th) the root contains 13·9 per cent. of oxalic acid 5·1 per cent. being soluble and the remainder insoluble. The proportion of ash is 20·7 per cent., and some of the acid is in the free state. When the plant is in active vegetation (June 26th) the proportion is about 10 per cent., and it is especially abundant in the leaves and branches, and least abundant in the root. The oxalates may exist in the form of double salts of potassium, calcium, and magnesium, or in that of ethereal salts which are ultimately decomposed in contact with calcium compounds. When the plant begins to fructify (September 27th) the absolute amount of oxalic acid has increased, but in much lower proportion than the increase of the whole plant; the percentage amounts to one-

* Rev. Ital. Sci. Nat., ii. (1886) pp. 61–3, from Ann. Ist. Bot. Roma, ii. (1886).

† Comptes Rendus, cii. (1886) pp. 995–1001, 1043–9. Cf. this Journal, vi. (1886) p. 90.

fourth of what it was at the early stage of growth. The leaves of *R. acetosa* are very rich in nitrogenous substances, and are the principal seat of the formation of oxalic acid and of the destruction of the nitrates.

Amaranthus caudatus contains a considerable proportion of nitrates, and the oxalic acid is mainly in an insoluble form. At the commencement of flowering (June 18th) the percentage of oxalic acid was 5·86.

Chenopodium quinoa yields a neutral juice which is almost free from nitrates, but contains a relatively large proportion of soluble oxalates. In the early stage of growth (May 18th) the percentage of oxalic acid was 3·9, and the bases in the ash (25·6 per cent.) were far more than sufficient to neutralize the whole of the acid.

Mesembryanthemum crystallinum.—The seed does not contain oxalic acid. In the early stage of growth (June 9th) a considerable quantity of oxalic acid is formed, a part being in the soluble form. As growth proceeds the juice becomes acid, and at a later stage, when the flowers begin to open, it becomes neutral in the root, but is acid in the stalks and leaves.

(4) Structure of Tissues.

Assimilating System.*—Dr. G. Haberlandt contests the theory of Stahl that the factor which exercises the greatest influence on the structure of the assimilating system of plants, and especially on the palisade-parenchyma of leaves, is the intensity of light. His view is rather that it is governed chiefly by the facility which it affords for the conduction of the food-materials. Although in the great majority of cases the statement of Stahl is correct, that in the palisade-cells the chlorophyll-grains take up their epistrophic or apostrophic position according to the direction and intensity of the light, yet it can be shown, especially in those instances where the walls of these cells are curved or oblique, that the determining influence is the anatomical structure of the walls themselves. Those cell-walls through which the current of food-material passes, or a regular metastasis takes place, are free of chlorophyll-grains.

The theory that the oblique position of palisade-cells is a direct contrivance for the transmission of light, is contradicted by the fact that it occurs in conditions where light is entirely excluded, as in leaves inclosed within buds or even buried in the ground. Evergreen leaves, even when growing in the shade, contain an abundant palisade-parenchyma. The author regards the influence of light on the greater or less development of the assimilating system as simply an example of irritation which has become hereditary; and where this inherited tendency to a copious development of the assimilating tissue is wanting, even the most intense illumination is powerless to produce it.

The principles of the structure of the assimilating tissue, on the above theory, are explained in detail; and it is pointed out that the arrangement best adapted for the assimilating cells to carry out their function is when they are placed radially round the vascular bundles.

Vascular Bundles of Zea Mays.†—Herr H. Potonié describes the development of the small anastomoses which, in the leaves of the maize, connect the principal longitudinal vascular bundles transversely with one another, and points out the singular fact that the conducting tissue represented by the parenchyma-sheath of these anastomoses is of the same origin as the elements of the anastomosing bundles themselves, and differs in origin from the parenchyma-sheaths of the principal bundles, which are of a similar value from a physiological point of view.

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 206–36 (1 pl.). † Ibid., pp. 110–2 (1 fig.).

Interruption in the Pith of Coniferæ.*—Herr C. Fritsch has determined that this phenomenon is due, not to external causes, but to changes in special groups of cells, ending in their complete disappearance. The cavities formed in this way are never filled with turpentine or resin. The phenomenon is confined to the genera *Picea*, *Abies*, *Larix*, and *Cedrus*, and is not found in all species of these genera.

Ant-entertaining Plants.†—In addition to the plants enumerated by Beccari ‡ as being inhabited by ants, Herr H. Karsten describes another, *Cecropia peltata*, in which the ants inhabit peculiar cavities in the internodes formed by a peculiarity in the growth of the plant. In those specimens in which ants have taken up their abode, these cavities are connected with one another by circular perforations, while in those which are not so inhabited, the cavities remain distinct.

Laticiferous Vessels.§—Sigg. Pirotta and Marcatili have studied the distribution and relations of the laticiferous system in a number of orders, with the general result of corroborating the suggestions of Haberlandt. ‖ (1) In *Apocynaceæ* the laticiferous vessels are distributed in a twofold manner within the leaf. (*a*) The vessels follow the veins to their last ramifications, forming a fine net in the parenchyma, and coming into more or less direct connection with the assimilating cells. (*b*) After accompanying the bundles so far, the laticiferous vessels leave them, penetrate freely into the parenchyma of the mesophyll, and become applied to the assimilating cells. (2) In *Asclepiadaceæ* (*a*) with reduced or modified leaves, the very numerous laticiferous vessels run in all directions through the assimilating subepidermal parenchyma of stem and branches, exhibiting close connection with the assimilating cells. (*b*) In those with normal leaves the connections between assimilating cells and the laticiferous vessels are much more manifest. They follow the veins and then part from them, traversing the parenchyma and frequently penetrating between the palisade-cells. (3) In *Euphorbiaceæ* (*a*) with reduced modified leaves the laticiferous vessels are cortical or medullary, but always in close connection with the assimilating cells. (*b*) In those with normal leaves the laticiferous vessels follow the vascular bundles for some distance, and then leave them, becoming isolated and exhibiting intimate connections with the green cells. (4) In *Campanulaceæ* and (5) *Lobeliaceæ* the vessels either accompany the bundles to their fine terminations, or traverse the parenchyma, often ending in the spongy tissue, surrounded by a considerable number of conducting cells. (6) In *Papaveraceæ* the laticiferous vessels follow the bundles and end with them, or else traverse the spongy tissue, and, passing between the palisade cells, end finally below the epidermis. (7) In *Araceæ* the laticiferous vessels frequently ramify in the parenchyma, or pass between the palisade cells to the epidermis. (8) In *Musa* the laticiferous vessels never leave the bundles, but become associated with the palisade cells.

(5) Structure of Organs.

Origin and Development of the Lateral Roots in Dicotyledons.¶—According to M. A. Lemaire, the immense majority of the lateral roots of

* Schrift. K. Phys.-Oek. Gesell. Königsberg, xxv. (1885). See Bot. Centralbl., xxvii. (1886) p. 218.

† Flora, lxix. (1886) pp. 304–6.

‡ See this Journal, v. (1885) p. 484.

§ Rev. Ital. Sci. Nat., ii. (1886) pp. 60–1, from Ann. Ist. Bot. Roma, ii. (1886).

‖ See this Journal, 1883, p. 868.

¶ Ann. Sci. Nat. (Bot.), iii. (1886) pp. 163–272 (6 pls.).

Exogens are of endogenous origin, from the deeper tissues of the stem; the Cruciferæ furnish an exception, the lateral roots being exogenous in that order. It is most frequently the case in Dicotyledons that the lateral roots are formed at the expense of a layer of cells at the periphery of the central cylinder of the stem itself formed from the pericycle. The roots are sometimes formed at the portion of the pericycle which faces the vascular bundles, sometimes at the side of the bundles, while sometimes they spring from the intervals between the bundles. When the pericycle is simple, it first divides into two layers by tangential walls; the lower layer gives birth to the central cylinder of the root; the superficial layer again divides into two, the inner layer producing the cortex, the outer the root-cap and the piliferous layer. When the pericycle is composed of several layers, the cells of the internal layer form the central cylinder of the root, while the cortex, the piliferous layer, and the root-cap spring from the outer layer.

The endoderm or the last layers of the cortex in some cases take their share in the development of the root. It gives place to a tissue (the *calotte*), composed of one or more layers which clothe the root-cap. Sometimes the cells of the endoderm, full of protoplasm, divide in the radial direction, and produce a layer of cells extending to the surface of the root-cap; or the endoderm first developes round the young root a layer which subsequently divides into two by tangential walls; or several inner layers of cortex are associated in producing several layers of "calotte." In some plants the cortex of the root is altogether inactive.

In plants belonging to the Leguminosæ the pericycle of the stem gives birth only to the central cylinder of the root, while the other parts are derived from the last layers of the cortex of the root. In some cases again (*Vinca major*, *Viola palustris* and *odorata*) the roots are not formed at the expense of the pericycle, but from a meristem situated within the liber of the bundles of the stem, in other words, from the intrafascicular cambium. In *Asperula odorata* the central cylinder of the roots proceeds from a generating layer beneath the liber; the other parts are produced from the pericycle. In the Cruciferæ the lateral roots are exogenous; their central cylinder is the result of divisions in the second layer of the cortex of the stem; their cortex results from segmentations in the outermost layer of this same cortical tissue; the piliferous layer and root-cap have a common origin, viz. the epidermis of the stem.

Aerial Roots of Sonneratia.*—Herr K. Goebel has examined the roots of this tree, growing in tropical swamps, and has determined that they are not pathological structures, as previously supposed, but normal roots which emerge from the water or mud owing to their negative geotropism. He regards their function as being connected with respiration, to bring the roots in direct contact with the atmosphere in consequence of the small amount of oxygen contained in the mud.

Structure and Function of the Subterranean Parts of Lathræa squamaria.†—Mr. G. Massee describes in detail the structure of the scale-leaves and "haustoria" of this plant, which he regards as a saprophyte rather than a true parasite. The haustoria or discs, by means of which nutriment is obtained from the host, are about a line in length, are best developed on the primary rhizome and its branches, and may be terminal or interstitial; sometimes they are so numerous as to give a moniliform appearance to the rootlets; but are sometimes almost altogether absent

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 249–55.
† Journ. of Bot., xxiv. (1886) pp. 257–63 (1 pl.).

from old roots. The central vascular portion of the disc penetrates to the pericycle of the host, from which it absorbs nutriment, the penetration being effected by the secretion of some corrosive substance.

The large cavities in the scale-leaves contain glands of three kinds, viz. (1) Stipitate glands springing from a single epidermal cell; the pedicel usually one-celled, the head composed of four cells filled with dense granular protoplasm; this is the most common form. (2) Sessile glands with a broadly elliptical basal cell; the head composed of four long narrow cells containing granular protoplasm; this form is also abundant. (3) Glands with long slender jointed pedicel and small multicellular head, agreeing in structure with the glands that cover the rachis and bracts, but which are very rare in the cavities. The cavities of the leaves do not contain air, but water with an acid reaction, due to a secretion from the stipitate glands. The large sessile glands exercise an absorptive function, certain inorganic and organic matters from the humus being in all probability absorbed and assimilated by the plant.

Further details are given of the nature of the tissues of which the scale-leaves are composed, as shown by microchemical tests.

In some instances the roots are covered by the mycelium of a fungus; but this is not sufficiently constant to regard the phenomenon as one of symbiosis similar to that which occurs in *Monotropa*.

Rhizopod-like Digestive Organs in Carnivorous Plants.*—Herren A. Kerner v. Marilaun and R. Wettstein v. Westersheim describe the contrivances for the capture and digestion of insects in *Lathræa squamaria* and *Bartsia alpina*. On the back of the underground non-chlorophyllaceous leaves of *Lathræa* are cavities, the inner walls of which are clothed with glandular organs of two kinds, stalked capitate hairs and sessile 2–4-celled sterile elliptical organs, the latter in connection with the vascular-bundle system of the leaf. The outer membrane of both organs is provided with extremely regular perforations, from which, under certain circumstances, extremely fine protoplasmic threads project outwards. These threads come into contact with the products of decomposition of the animals (infusoria, mites, &c.) which perish in the cavities. No excretion of any special fluid could be detected. At the commencement of the period of vegetation, the absorption of nutriment in *Lathræa* takes place chiefly through the haustoria, and the quantity of the remains of animals found in the cavities is extremely small. Towards autumn the haustoria partially disappear, and the number of insects captured increases.

In *Bartsia alpina* similar organs are found in peculiar hollows formed by the leaves, the margins of which are recurved in vernation. The leaf-buds are underground, and the structure of the cavities is similar to that in *Lathræa*.

Forms of Leaves and Cotyledons.†—The presidential address of Sir John Lubbock to the Linnean Society is devoted to a discussion of the forms of the leaves and cotyledons of Flowering Plants in relation to their biological requirements. After a few remarks on leaves, especially in regard to their form and their venation, he proceeds to a discussion of seedlings. The variations in the cotyledons of dicotyledonous plants are described, especially in relation to their size and form, the likeness or unlikeness of the two cotyledons to one another, and the size of the embryo in comparison to that of the seed. Sir John Lubbock concludes that the conditions under which seedlings are grown naturally exert some influence

* SB. K. Akad. Wiss. Wien, xciii. (1886) (1 pl.). See Bot. Centralbl., xxvii. (1886) p. 289.

† Journ. Linn. Soc. Lond. (Bot.), xxxii. (1886) pp. 341–401 (134 figs.).

on the form of the leaves; and he finds an almost inexhaustible supply of beautiful adaptations to purpose in this respect; while, on the other hand, there are not wanting cases in which it would seem that the adaptation is not complete.

Leaves of Water-plants.*—M. J. Costantin publishes the results of a large number of observations on the peculiarities of the morphology and internal structure of the leaves of plants growing either normally or accidentally in water.

As a general law it may be stated that submersion modifies the development of leaves, tending to increase their surface at the expense of their thickness, whether in one plane or by numerous capillary subdivisions. If a plant growing in the air is submerged the undeveloped leaves will undergo changes in this direction, while the adult leaves will perish; in the former case the changes of medium may act directly or indirectly in bringing about adaptations in the leaves. The capillary division of the leaves of aquatic plants occurs exclusively with Dicotyledons (*Ranunculus*, *Myriophyllum*), while elongation in one direction is chiefly characteristic of Monocotyledons (*Sagittaria*, *Vallisneria*, &c.). Many aquatic plants have different forms of leaves, according as they are submerged, floating, or aërial (*Sagittaria*, *Alisma*, *Nuphar*).

As regards the structure of the epidermis, the immediate action of an aquatic medium is manifested in the complete or approximate disappearance of stomata from the submerged leaves and from the lower surface of floating leaves; and in the submerged leaves of plants normally aërial, by the diminution of their number on the upper as compared with the lower surface. In *Stratiotes* the exposed portion of the leaf possesses stomata, while the submerged portion of the same leaf is destitute of them. In a plant growing in shallow water, the stomata may be formed even in the bud on leaves which will subsequently expand on the surface or be completely exposed. Further changes are shown in the walls of the epidermal cells becoming rectilinear and diminishing in thickness, in the external wall (cuticle) not becoming suberized, in the disappearance of hairs, and in the appearance of chlorophyll in the epidermal cells. In the mesophyll the lacunæ show a tendency to increase in number, accompanied by a reduction of the fibrovascular and other strengthening elements. The palisade-tissue also disappears or becomes greatly reduced. These changes appear to be the direct result of the change of medium.

Growth of Hairs on Etiolated Organs.†—From the examination of a large number of plants artificially etiolated, Herr A. Schober concludes that etiolation does not itself affect the form or length of the hairs on the stem, leaves, or root; although the hairs are larger or smaller in proportion to the vigour of growth of the plant itself.

Cilia of Luzula.‡—According to Herr F. Buchenau the cilia on the leaves of all species of *Luzula* are expansions, not of the epidermis of either surface only, but of a layer of cells resulting from the union of the epidermis of both surfaces. They consist of three or four cells at the base, at the apex of a single apiculate cell. In the allied genus *Juncus* a similar structure was found only in *J. trifidus*.

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 94–162 (5 pls.). Cf. this Journal, 1885, p. 674.

† Zeitschr. f. Naturwiss., iv. (1886) pp. 556–78. See Bot. Centralbl., xxviii. (1886) p. 39.

‡ Abhandl. Naturwiss. Ver. Bremen, ix. (1886) pp. 293–9. See Bot. Centralbl., xxvii. (1886) p. 220.

Morphology of the Flower of Orchideæ.*—Prof. E. Pfitzer describes in great detail the structure of the flower of orchids, the result of observations on a very large number of species, chiefly exotic.

The inferior unilocular ovary he regards as a hollow flower-stalk, down the inner surface of which run the margins of the three carpels as semi-niferous placentæ.

The spur varies greatly in morphological value. We have (1) spurs of purely axial character (*Epidendron*, *Lælia*, *Cattleya*, *Dendrobium*, &c.); (2) spurs which are half-axial (*Chænanthe*, *Comparettia*, *Phajus*, *Saccolabium*, *Anectochilus*); (3) of purely foliar nature (*Disperis*, *Huttonæa*, *Coryanthes*).

The labellum may be divided into three parts:—hypochilium, mesochilium, and epichilium. The labellum does not in all cases correspond to the median petal; one or more of the other petals or the axis may take part in its formation.

Prof. Pfitzer dissents from the ordinary conception of the column as a product of the adhesion of the upper part of the carpels with one or two fertile stamens, in addition sometimes to two or three staminodes. He regards the column, on the contrary, as purely axial in its character, similar to that of *Passiflora*, *Cleome*, and *Gynandropsis*. There are all stages of transition between orchids with no gynostemium, like *Diuris*, and those with a long and slender column; as also between those with true pollinodes and those with ordinary powdery pollen.

Development of the Flowers and Fruit of Typha and Sparganium.†—According to Dr. S. Dietz the development of the flowers in these two genera, while showing in many respects a general relationship, exhibits such material differences as to justify their being placed in different families. The seed of *Typha* contains a single layer of perisperm and an endosperm composed of several layers; the long embryo occupying a central position along the axis of the seed; the small-celled and thin-walled perisperm can only be made out by staining. The detection of the aleurone-grains and nucleus in the cells of the perisperm is also difficult without staining, but the author states that he was able to determine the invariable presence of the latter.

Pollen of Iris tuberosa.‡—Under the name of "Gasparrini's vesicular organ," Sig. G. Licopoli describes a peculiar vesicular structure which he finds in the pollen-grains of *Iris tuberosa*, and of some other monocotyledonous plants. It appears to be nothing but the vegetative cell of the pollen-grain or its nucleus.

Nectary of Erythronium.§—Dr. S. Calloni describes in detail the structure of the nectary of *Erythronium dens-canis*, which does not, however, present any striking peculiarities. Its position is designed to assist in the cross-fertilization of the flower, especially by Hymenoptera and Coleoptera.

Seeds of Aldrovanda.‖—Herr S. Korzchinsky describes the structure of the seeds of *Aldrovanda vesiculosa*. The integument consists of five layers:—an outermost black palisade-layer, a delicate spiny lamella, an inner brown palisade-layer, a delicate colourless layer, and the innermost

* Pfitzer, E., 'Morphologische Studien üb. d. Orchideenblüthe,' 139 pp. and 64 figs., Heidelberg, 1886.

† Bot. Centralbl., xxviii. (1886) pp. 26–30, 56–60.

‡ Atti R. Accad. Sci. Fis. Napoli, ii. (1885) (1 pl.). See Malpighia, i. (1886) p. 36.

§ Malpighia, i. (1886) pp. 14–9 (1 pl.).

‖ Bot. Centralbl., xxvii. (1886) pp. 302–4, 334–5 (1 pl.).

integument; these inclose the ovoid nucellus. The germination of the seeds was also followed out, presenting the peculiarity of the almost complete suppression of the radicle.

Latent Vitality of Seeds and Rhizomes.*—Dr. Fritz Müller writes from Brazil to Dr. F. Ludwig, noting some interesting cases in which seeds or rhizomes must have remained for a long time latent. In a felled wood a variety of *Ricinus*, seedlings of Mandioc, a conspicuous *Caladium*, a *Dioscorea*, &c., sprang up as the results of cultivation twelve years before, though before the ground was recleared there was no trace of them. In another case an individual *Gloriosa superba* was lost for eight years, during which it must have remained latent. The shades of the wood afford very uniform conditions which favour this retention of life without development.

β. Physiology.†

(1) Reproduction.

Fertilization of the Hollyhock and of Indigofera.‡—Contrary to the general opinion, and notwithstanding the size and beauty of the flower, Mr. T. Meehan maintains that the hollyhock is necessarily self-fertilized, and that this self-fertilization is assisted by insects. When insects seat themselves on the open anthers immediately after the opening of the flower, they force a quantity of pollen down into the staminal tube upon the immature stigmas. When the stigmas rise above the mass of anthers and are ready for pollination, they are so entirely covered by this pollen, that it is almost impossible for a grain of foreign pollen to reach them.

The structure of the flowers of *Indigofera Dosua* Mr. Meehan regards as specially favourable neither to self-fertilization nor to cross-fertilization; but the great probability is that in the majority of cases the flowers are self-fertilized.

Fertilization of Labiatæ and Borragineæ.§—Herr E. Loew describes in detail the adaptations to insect fertilization in the flowers of a number of species belonging to these two natural orders.

The Labiatæ are visited chiefly by humble-bees and other bees with a long proboscis; next in the frequency of their visits come butterflies and flies; and last, bees with a short proboscis, and insects belonging to other orders. By far the greater number of the species are proterandrous. Further contrivances for preventing self-pollination and for the scattering of the pollen are described. The cause of attraction of insects is the odour of a strongly aromatic essential oil. As regards the history of development of the flowers of the Labiatæ, the author suggests that the primary form is a short-tubed pentamerous corolla with a distinct tendency to zygomorphism, a nectariferous ring beneath the ovary, and a strong tendency to proterandry.

The Borragineæ agree with the Labiatæ in the classes of insects which take the chief part in their fertilization, bees with a short proboscis coming next, and butterflies and flies last of all, the number visited by butterflies being very small. The contrivances for pollination are by no means so numerous as in the Labiatæ; among them may be mentioned the peculiar nature of the inflorescence so constant in the order, and the

* Biol. Centralbl., vi. (1886) pp. 513–4.

† This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

‡ Proc. Acad. Nat. Sci. Philad., 1886, pp. 291–4.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 113–43, 152–78, 198–9 (3 pls.).

common occurrence of a change in the colour of the corolla. In *Arnebia echioides* he finds that the long-styled form exhibits only a slight decrease of fertility when impregnated with its own pollen.

Fertilization of Yucca.* — Mr. W. Trelease corrects Prof. Riley's observation with regard to the presence of a nectary in the stigma of the capsular Yuccas, no secretion taking place from the stigma except that of the stigmatic fluid. He confirms Riley's statement that the yucca-moth (*Tegeticula yuccasella*) deliberately goes to the stamen and accumulates a supply of pollen on its remarkable spinose tentacles before beginning the work of pollination and oviposition.

New Case of Parthenogenesis.†—Dr. A. Ernst describes a plant found by him in Caracas, and named *Disciphania Ernstii*, belonging to the Menispermaceæ, which appears to exhibit true parthenogenesis. Female plants which bore no male flowers, and which were grown perfectly isolated where there was no possibility of the access of pollen from another plant, produced in three successive years an increasing number of fertile fruits. Dr. Ernst was unable to determine whether the embryo was developed as an outgrowth from a cell of the nucellus, as in *Cœlebogyne*, or whether it was the development of an unfertilized oosphere; but he believed it to be the latter. The fertile flowers appeared to be developed on embryos with a thicker rachis than the barren ones.

(2) Germination.

Formation of Endosperm-Tissue.‡—According to observations made on a number of species of dicotyledonous plants by Herr F. Hegelmaier, the usual statement that the formation of the endosperm takes place in two different ways, either by free-cell-formation or by the division of the embryo-sac, must be accepted with some modification. The cases included under the former head are not referable to free-cell-formation in the strict sense of the term, but rather essentially to the division of a protoplasm-body. The term free-cell-formation can only be retained if it is applied to all those cases where the formation of fresh septa appears to be quite independent of the previous divisions of the nucleus.

In *Lonicera caprifolium* the protoplast of the broadly fusiform embryo-sac, which is surrounded only by the thick integument, forms before impregnation, as respects the greater part of it, a rather thin parietal layer; the nucleus being not in the centre, but in a peripheral position close to the egg-apparatus. As the embryo-sac increases in size, the nucleus divides by repeated bipartition. During the later stages of this bipartition, a number of small vacuoles are formed in the parietal layer, and the embryo-sac presents, on superficial view, the appearance of a net. The entire embryo-sac may now become suddenly filled with a cellular mass, and all intermediate stages occur between this and a simple parietal layer. The division-walls of the tissue thus formed show the same capacity for staining with carmine and iodine, and the same resistance to sulphuric acid as the protoplasm. The cell-cavities of this structure are unquestionably derived from the vacuoles in the protoplasmic layer, the division-walls from the separating bands of protoplasm. Differentiated septa of cellulose are formed at a subsequent period.

In *Viburnum* and *Sambucus* the embryo-sac is shorter and broader than in *Lonicera*. No vacuoles appear in the parietal layer of protoplasm; the

* Bull. Torrey Bot. Club, xiii. (1886) pp. 135–41 (3 figs.).
† Nature, xxxiv. (1886) pp. 549–52 (16 figs.).
‡ Bot. Ztg., xliv. (1886) pp. 529–39, 545–55, 561–78, 585–96 (1 pl.).

entire inner cavity of the embryo-sac presenting the appearance of being instantaneously broken up by thin lamellæ of protoplasm. In *Symphoricarpus* the variation in the same direction from the structure in *Lonicera* is still more strongly displayed, a powerful development of protoplasm taking place in the centre of the embryo-sac in the form of a mass of chambers, the dividing walls of which consist of protoplasm in which septa of cellulose subsequently make their appearance. The division of the embryo does not begin in the Caprifoliaceæ until after the complete formation of this endosperm.

Adoxa agrees essentially with *Sambucus* in the mode of development of the endosperm, differing altogether from that of *Chrysosplenium* with which some authors propose to associate it. *Hedera* shows affinity in this respect with the Caprifoliaceæ, especially *Viburnum* and *Sambucus*, rather than with the Umbelliferæ. The ovule is monochlamydeous and bilateral, but is distinguished from that of the two genera named by the presence of a small quantity of nucellar tissue at the time of flowering.

In *Galium* and *Asperula* no vacuoles are to be discovered in the parietal layer of protoplasm in the embryo-sac, nor any breaking up into chambers. The protoplasm subsequently breaks up into a number of polyhedral cells, some of which contain two or three nuclei, though finally the endosperm consists of uninucleated cells. The suspensor branches into a number of haustorium-like appendages which penetrate the endosperm.

In *Borrago* the author was unable to confirm the statement of Hofmeister of the formation of an endosperm-tissue at the chalaza-end of the embryo-sac. There is here a central band of protoplasm running in a longitudinal direction through the embryo-sac, which afterwards breaks up into a number of plates. *Heliotropium* had been described by Rosanoff as exhibiting free-cell-formation in the upper, cell-division in the lower part of the embryo-sac; Hegelmaier was unable to confirm this; finding, in the lower part as well as the upper, the formation of septa coincident with the division of the nucleus. Strictly speaking, in *Heliotropium* the embryo-sac itself does not divide in the formation of endosperm, but only its contents; and this is still more strikingly the case in *Specularia*.

In *Atropa* the endosperm is the result of true cell-division; as is also the case in *Asarum*. In the Labiatæ the embryo-sac is divided by an isthmus-like neck into two parts of unequal size, and the formation of endosperm takes place only in the smaller of these by cell-division.

The author next points out differences in the mode of development of the endosperm in *Nuphar* and *Nymphæa*, although belonging to the same type.

He concludes that no sharp line of demarcation can be drawn between different modes of development of the endosperm, whether you take as the distinguishing character the coincidence or otherwise of the formation of septa with the division of the nucleus (cell-division and free-cell-formation), or the fact that in some cases it is the embryo-sac itself that divides, in other cases only its protoplasmic contents.

(4) Growth.

Effect of Sunlight on Etiolated Seedlings.*—According to Dr. J. Reinke, when etiolated seedlings of cress were placed under a normal solar spectrum, the green colouring invariably took place most rapidly on both sides of the line C, about in the interval λ 635–λ 675; the curve falling

* SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 94.

from this maximum towards both ends of the visible spectrum. When the light was sufficiently strong, heliotropic curvatures took place even in the yellow.

Assumed Decomposition of Carbonic Acid by Chlorophyll.*—Reverting to this subject, Dr. N. Pringsheim repeats his previous arguments that we have no direct evidence that the colouring matter of chlorophyll is the agent which brings about the decomposition of the carbon dioxide of the atmosphere. So far from the blue and violet rays, which are the most eagerly absorbed by chlorophyll, being the most active in the decomposition of carbon dioxide, they are almost inoperative in diffused daylight. The author also lays stress on the fact that in artificial solutions of chlorophyll obtained from leaves there is no mutual reaction between the colouring matter and the carbon dioxide of the air; but that, on the contrary, when exposed to light, the chlorophyll loses its colour and gives off carbonic acid; and experiment proves that the same takes place in every living cell under the influence of light. While pure carbon dioxide produces no effect on the chlorophyll of the living cell, the least trace of oxygen bleaches and destroys it in the course of a few minutes, when exposed to a sufficiently intense illumination.

Decomposition of Carbonic Acid by Chlorophyll outside the plant.†—Dr. N. Pringsheim contests the accuracy of the observations of Regnard, according to which carbon dioxide was decomposed by a layer of chlorophyll placed on strips of cellulose.

He also comments on the statement of Timiriazeff, that a substance can be obtained from chlorophyll by reduction by means of hydrogen in a nascent condition, which has the same property of decomposing carbon dioxide; and points out that if this observer's last observations are correct they altogether contradict his previous statement ‡ with regard to the coincidence of the maximum of evolution of oxygen with the absorption-band in the red in the spectrum of chlorophyll, and confirms Pringsheim's own views on this subject. §

(6) Movement.

Theory of Twining.—In pursuance of the controversy on this subject, Prof. S. Schwendener ‖ replies to the arguments of Wortmann, ¶ insisting on the importance of the clasping movement (Greifbewegung) as an element in the causes of twining, this movement not being by any means confined to the free apical portion of the stem. His observations were made almost exclusively on *Calystegia dahurica*. He contends that the phenomena of this and other twining plants cannot be accounted for by the operation of nutation and geotropism alone, the comparative rapidity of the movements and their permanent character being evidence of this. The free movement of the apex due to nutation and geotropism may even be entirely suppressed, without the process of coiling altogether disappearing.

To this Dr. J. Wortmann ** replies, maintaining that Schwendener's theory applies only to cases of coiling round a firm support, and is inadequate to explain circumnutations, free coilings, and homodromous torsions.

* SB. K. Preuss. Akad. Wiss., 1886, pp. 651-62. Cf. this Journal, 1880, pp. 117, 480; 1881, p. 479; 1882, pp. 220, 818; 1886, p. 825.

† SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 92.

‡ See this Journal, 1885, p. 837; 1886, p. 1015.

§ Ibid., 1886, p. 825.

‖ SB. K. Preuss. Akad. Wiss. Berlin, 1886, pp. 663-72.

¶ See this Journal, 1886, p. 283.

** Bot. Ztg., xliv. (1886) pp. 601-12, 618-25, 633-42, 649-58, 665-73, 681-90 (3 figs.).

Further observation has convinced him that rotating nutation or circumnutation is not an independent or spontaneous movement, but that it arises from the co-operation of at least two factors, negative geotropism and an external or internal force, which factor displays itself in the unequal growth of the two sides of every growing and rotating stem or tendril. In every growing zone, even the youngest, of internodes capable of coiling, there is a sensitiveness to the action of gravitation; in other words, every such zone is negatively geotropic; and this combines in its effects with the homodromous or transverse curvature resulting from the unequal growth above referred to, which Wortmann proposes to call the "flank-curvature" (Flanken-Krümmung). According as the right or left side grows the faster, the organ in question curves to the left or the right respectively. This movement he regards, not as geotropic, but as purely spontaneous.

Commenting on the same paper, Herr F. Noll * justifies his distinction of different kinds of coiling into simple and complicated, "clasping movement" and torsion taking no part in producing the former.

Absorption of Water in the fluid state by Leaves.—Herr L. Kny † refers to statements made by different writers as to the power possessed, under certain circumstances, by the aerial organs of many plants, to absorb water in the fluid condition, especially those of Lundström, whose results he is unable to confirm. Among a number of plants examined, *Dipsacus laciniatus* and *Fullonum* were the only ones which manifested this faculty. In these plants the small quantity of water absorbed by the leaves could only be of the very slightest advantage to the mature leaves, though it might be to the upper portion of the stem and the leaves of the terminal bud and inflorescence.

To this Herr A. N. Lundström ‡ replies that, while he is able to state with confidence that some plants, e. g. *Stellaria media*, do under certain conditions absorb water through the leaves, he has not maintained this to be a universal phenomenon; but that the most important direct beneficial effects of rain and dew on the leaves of plants consist in washing the leaves and in regulating the transpiration in the way of either increase or diminution.

(7) Chemical Processes (including Fermentation).

Moist Gangrene of the Cauliflower.§—Prof. O. Comes has investigated the cause of this disease, very prevalent in the neighbourhood of Naples, which manifests itself in all the vessels being filled with gum. He finds in the plants attacked the parasitic fungus *Pleospora Napi* or its conidiiferous form *Sporidesmium exitiosum*, generally considered to be the cause of the disease, as well as *Cladisporium* and *Macrosporium Brassicæ*; but regards these fungi as merely accessory phenomena; and believes the source of the disease to be gummy degeneration and putrid fermentation of the tissues, caused by too great richness of the soil, and a too abundant supply of water.

Exchange of Gases by Buds.‖—M. L. Mangin has experimented on the changes produced in the surrounding atmosphere by recently detached buds of various trees. The results vary with different species. As a

* Bot. Ztg., xliv. (1886) pp. 738–40.

† SB Versamml. Deutsch. Naturf. u. Aerzte, Sept. 22, 1886. See Bot Centralbl., xxviii. (1886) p. 125.

‡ Bot. Centralbl., tom. cit., p. 317.

§ Atti R. Ist. Incorragiamento Sci. Nat., iv. (1885). See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 128.

‖ Bull. Soc. Bot. France, viii. (1886) pp. 185–90.

general result, the exchange of gases is in autumn feebler in leaves than in buds, and, in the case of leaves, diminishes rapidly before their fall. In the few weeks or days preceding the fall of leaves an energetic oxidation takes place in their tissues. On the other hand, the proportion $\frac{CO_3}{O}$ remains below unity in certain cases, as the elm and lilac, during the winter period, while in others it rises almost to unity in the spring. In some, as the cherry, the proportion diminishes rapidly at the moment of unfolding of the buds. The oxidation which takes place in buds in winter appears at this period to decrease rapidly in intensity.

γ. General.

Sorauer's Handbook of the Diseases of Plants.* —The first part of the second greatly enlarged edition of this work treats of those diseases of plants which are not due to parasites, and is divided into eight chapters, as follows :—(1) Diseases caused by unfavourable conditions of nutrition; (2) by unfavourable atmospheric conditions; (3) by injurious gases and fluids; (4) by wounds; (5) formation of knots; (6) galls; (7) diseases due to deliquescence; (8) to weeds.

Prehistoric Plants.† —In his address to the Biological Section of the British Association (Birmingham Meeting), Mr. W. Carruthers first described the wonderful state of preservation of the flowers obtained by Dr. Schweinfurth from mummy-wrappings in Egypt, even such evanescent colours as the violet of the larkspur and knapweed, and the scarlet of the poppy, the chlorophyll-remains in the leaves, and the sugar in the pulp of the raisins, being preserved. The remains of 59 species of flowering plants have been identified.

In stratified clays resting on the boulder clay in the valley of the Nile, have been found the remains of 2 species of Desmidieæ, 31 of Diatomaceæ, and 9 of flowering plants, all belonging to the existing agrarian flora. In another locality 51 species of moss have been determined with certainty, a considerable proportion being alpine plants, one of them no longer found in Britain. These beds also contain 7 species of seaweed now found in our seas.

The sedimentary deposits at Cromer, of later date than the Pliocene strata, are the earliest in which remains of plants have been found that can certainly be identified with species existing at the present time. Some of the plant remains from Tertiary strata have been referred to still living species, but, as Mr. Carruthers thinks, without sufficient evidence.

Strasburger's Practical Botany.‡—This world-renowned book which has already been translated into French and even Russian, is now issued in English, having been translated by Prof. W. Hillhouse. The author has revised the translation and partly rewritten some portions. There are many additional notes both by author and editor, those of the editor being intended to either simplify or amplify the description or to enable the material selected by the author to be replaced by some other, probably more readily obtainable. The introduction on instruments and apparatus he has nearly rewritten, to make it more suited for English students.

* Sorauer, P., 'Handb. d. Pflanzenkrankheiten,' 2te Aufl., 1er Th., 920 pp., 19 pls., and 61 figs.

† Journ. of Bot., xxiv. (1886) pp. 309–18.

‡ See this Journal, 1885, p. 332. Engl. ed., 8vo, London Swan, Sonnenschein, Lowry and Co., 1887.

The design of the book is sufficiently shown by the opening paragraphs of the author's preface.

"This book is intended for those who, without desiring to become botanists by profession, wish nevertheless to become acquainted with the elements of scientific structural botany. It will likewise introduce the beginner to the various methods of microscopical manipulation.

The study of vegetable structure is especially favourable as an initiation into the use of the Microscope; and any one whose future career will require command over this instrument should commence with the study under the Microscope of vegetable anatomy.

The manual is divided into thirty-two chapters, each of which is intended to provide materials for several hours' practical work in the laboratory. The earlier chapters are easy, and the difficulties to be encountered increase almost continually up to the last chapter. The first chapter assumes on the part of the worker entire ignorance as to the use of his instruments, but nevertheless assumes the possession of some general botanical knowledge. With this elementary preparation the beginner ought to be able, by the diligent use of this book alone, to acquire a tolerably broad knowledge both of vegetable structure and of the methods of microscopical work."

In our notice of the original work we characterized it as "extremely useful"; experience has proved that this was but faint praise. In its improved English form it will take an even higher place as a leading handbook for microscopical manipulation.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Fertile Shoots of Equisetum.*—According to Herr K. Goebel the fertile shoots of all those species of *Equisetum* in which these shoots differ in structure from the barren shoots, result from the transformation of the latter, both in a phylogenetic and in an ontogenetic sense, due to an arrest of development. The difference consists essentially in the absence of chlorophyll, the suppression of branching, the temporary duration of the stem, and the absence of stomata; as well as in the greater development of the sheaths, which is difficult to explain from a biological point of view. This view is confirmed by the fact that it is possible artificially to induce the fertile shoots of *E. arvense* to put out green branches from the lower internodes, chlorophyll being also formed in the main axis. This may occur even in nature, producing the forms known as *E. irriguum* and *riparium*. There is therefore no sharp line of demarcation to be drawn between the two sections of the genus known as "homophyadic" and "heterophyadic."

Ulodendron and Bothrodendron.†—M. R. Zeiller agrees with Kidston in arranging the fossil structures hitherto classed under *Ulodendron* in three groups, and in referring the first to *Lepidodendron*, and the second to the genera *Ulodendron* and *Rhytidodendron*, the latter including the *Bothrodendron* of Lindley and Hutton; but he does not accept Kidston's view that the structures classed under *Ulodendron* belong to the section *Clathraria* of *Sigillaria*. They are distinguished from these by the leaf-scars being contiguous and arranged in oblique series.

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 184–9.

† Bull. Soc. Geol. France, xiv. (1886) pp. 168–82 (2 pls.). See Bull. Soc. Bot. France, 1886, Rev. Bibl., p. 108.

Fossil Rhizocarps.*—Sir W. Dawson describes the organs of fructification of cryptogams obtained from the Erian (Devonian) formation in Canada and the northern United States. He now regards the organisms previously described as sporangia under the name of *Sporangites*, and placed under Lycopodiaceæ, as more nearly allied to the Rhizocarpeæ and especially to *Salvinia*. He prefers for the whole group the name previously suggested by him, *Protosalvinia*, though it probably includes several genera of Rhizocarpean affinities. The detached discs may be regarded as macrospores, and their cellular envelopes as sporocarps. The diagnoses are now given of five species, viz. *P. huronensis*, *brasiliensis*, *bilobata*, *Clarkei*, and *punctata*. Sir W. Dawson believes the rhizocarpean macrospores to be the cause of the highly bituminous character of the shales which are charged with them, though there are shales which depend for their inflammable matter on microscopic debris of an entirely different character.

Muscineæ.

Capsule of Mosses as an Assimilating Organ.†—Herr F. Magdeburg has examined the structure and functions of the loose air-containing tissue found in the capsule of a large number of mosses between the outer wall and spore-sac or foot of the columella, the intercellular spaces being especially developed at the neck and apophysis, where also are the greater number of stomata. That this development is not connected with the absorption of moisture is shown by the fact that it is least marked in those mosses which grow in water or in very wet places, such as *Climacium*, *Dicranum palustre*, *Rhynchostegium rusciforme*, *Aulacomnium palustre*, &c., while those which grow in dry habitats, as *Grimmia pulvinata*, *Funaria hygrometrica*, *Polytrichum piliferum*, and species of *Barbula* and *Bryum*, display it to a considerable extent. For the same reason it is obviously not connected with the process of transpiration; and similar objections apply to its being associated with respiration.

The author then adduces reasons for connecting the development of this tissue with the process of assimilation; the chief reasons being the abundance of chlorophyll which it contains, and the presence of a large number of stomata.

The structure of the capsule of a considerable number of species is described in detail; and it is pointed out that the form of this organ is chiefly determined by its assimilating character, its complication of structure being in proportion to the development of the latter. In the Cleistocarpeæ, Sphagnaceæ, and Andreæaceæ the power of assimilation of the capsule is reduced to a minimum; while in *Polytrichum*, *Bryum*, *Mnium*, and other erect Stegocarpeæ it is very considerable. In proportion to the development exhibited by mosses is the independence of the sporogonium.

This power of assimilation resides to the greatest extent in the spore-sac, next in the innermost layers of the wall of the capsule, and finally in the characteristic tissue of the apophysis or neck.

Muscineæ of Central Africa.‡—Mr. W. Mitten describes the Mosses and Hepaticæ collected by the late Bishop Hannington in Central Africa, and by Mr. H. H. Johnston on Kilimanjaro, including a large number of new species.

* Bull. Chicago Acad. Sci., i. (1886) pp. 105-18 (1 pl.).

† Magdeburg, F., 'Die Laubmooskapsel als Assimulationsorgan,' 32 pp. and 2 pls., Berlin, 1886.

‡ Journ. Linn. Soc. Lond. (Bot.), xxii. (1886) pp. 298–329 (5 pls.).

Classification of Sphagnaceæ.*—Pursuing his researches on the classification of Sphagnaceæ, Dr. Röll adopts Schliephacke's arrangement of the species under 7 heads, viz. I. Acutifolia, 2. Cuspidata, 3. Squarrosa, 4. Rigida, 5. Mollusca, 6. Subsecunda, 7. Cymbifolia. The species are then arranged as follows:—(1) *Schimperi* W., *Schliephackeanum* W., *acutifolium* Ehrh., *Wilsoni* n. sp., *plumulosum* n. sp., *fuscum* Kl., *Warnstorfii* n. sp., *robustum* Russ., *Girgensohnii* Russ., *fimbriatum* Wils., *Wulfii* Girg. (2) *Lindbergii* Sch., *riparium* Angs., *Limprichtii* n. sp., *recurvum* Pal., *intermedium* Hoffm., *cuspidatum* Ehrh., *laxifolium* Müll. (3) *teres* Angs., *squarrosum* Pers. (4) *rigidum* Sch., *molle* Sull., *Angströmii* Hart. (5) *tenellum* Ehrh. (6) *laricinum* Spr., *subsecundum* Nees, *contortum* Schltz., *turgidum* Müll., *platyphyllum* Sull. (7) *medium* Limp., *glaucum* Kling., *cymbifolium* Hedw., *subbicolor* Hpe., *papillosum* Lind., *Austini* Sull. Under each species the varieties and subvarieties are minutely described, and a table given of the probable genetic relationship of the various forms.

European Sphagnaceæ.†—M. J. Cardot classifies the Sphagnaceæ of Europe under thirteen species, recognizing as a species any group of forms distinguished by morphological characters of sufficient importance which are constant, and which do not pass by insensible gradations into those of another group. Where a group is marked by characters not of such absolute constancy, and which do in some cases pass into those of another group, he regards such a group as a sub-species. The characters chiefly relied on are those of the cauline leaves, the epidermis of the stem, a transverse section of the branch-leaves, and those of the lageniform cells; discarding altogether, as of no specific value, characters derived from the presence or absence of fibres in the cauline leaves, from the capsule and perichætial leaves, or from the inflorescence.

On these principles the European Sphagnaceæ are grouped as follows:—Group I. SPHAGNA CYMBIFOLIA. 1. *S. cymbifolium* Hedw. (subsp. medium Limpr., papillosum Lindb., Austini Sulliv.). Group II. SPHAGNA TRUNCATA. 2. *S. Angstrœmii* Hartm. 3. *S. rigidum* Sch. 4. *S. molle* Sulliv. Group III. SPHAGNA SUBSECUNDA. 5. *S. tenellum* Ehrh. 6. *S. subsecundum* N. v. Ees. (subsp. laricinum Spr.) 7. *S. Pylaiei* Brid. IV. S. ACUTIFOLIA. 8. *S. teres* Angstr. (subsp. squarrosum Pers.). 9. *S. fimbriatum* Wils. 10. *S. acutifolium* Ehrh. (subsp. Girgensohnii Russ.). 11. *S. Wulfianum* Girg. V. S. UNDULATA. 12. *S. Lindbergii* Sch. 13. *S. recurvum* P. B. (subsp. cuspidatum Ehrh.).

New Hepaticæ.‡—Herr V. Schiffner describes three new species of Hepaticæ from Hänke's collection, viz. *Lejeunia repanda* and *L. perforata* from Mauritius, and *Phragmicoma Hænkeana* from Mexico; also a monœcious species of *Riella*, *R. Battandieri*, from Algeria. He considers *Riella* as departing from all other genera of Hepaticæ in the absence of a bilateral structure. Archegonia and leaflets occur not unfrequently, not only on both faces of the wings, but even on the side of a rib opposite to a wing.

Algæ.

Alga parasitic on animals.§—Dr. A. Peter describes a new species of alga which he finds forming flat discs about 12 mm. in diameter on the carapace and other parts of *Emys europæa*. The systematic position of the alga,

* Flora, lxix. (1886) pp. 33–47, 73–80, 89–94, 105–11, 129–37, 179–87, 227–42, 328–37, 353–70, 419–27, 467–76 (1 pl.). Cf. this Journal, 1886, p. 108.

† Bull. Soc. R. Bot. Belg., xxv. (1886) pp. 19–136 (2 pls.).

‡ Bot. Centralbl., xxvii. (1886) pp. 207–11, 239–43 (1 pl.).

§ SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 22, 1886. See Bot. Centralbl., xxviii. (1886) p. 125.

for which he proposes the name *Dermatophyton radians*, is uncertain. The mode of growth resembles that of *Coleochæte;* but it forms a continuous parenchyma with thick cell-walls, resulting from repeated horizontal divisions of all the cells cut off from the marginal cells and from intercalary divisions. The lowest cell of each of these erect rows elongates below to a wedge-shaped form, and penetrates into the horny tissue of the shell, as the marginal cells of the whole plant do. By this means the shell is broken up into lamellæ. The mode of reproduction is not described.

Algæ epiphytic on Nymphæaceæ.*—Sigg. G. B. de Toni and D. Levi have examined the algæ found attached to the leaves of *Nymphæa alba* and *Nuphar lutea* in the botanic garden at Padua. They find 39 species in all, of which 19 are new to the Venetian flora. They comprise 24 species of diatoms, 2 Chroococcaceæ, 2 Oscillariaceæ, 1 Rivulariacea, 1 Coleochætacea, 2 Œdogoniaceæ, 1 Volvocinea, 5 Protococcaceæ, and 1 Conjugata.

Action of Algæ upon Water.†—According to M. E. Bréal, the microscopic algæ in fresh water decompose bicarbonate of lime dissolved in the water, and thus give rise to a calcareous deposit. Being able to live in neutral or slightly alkaline liquids, they may, by the oxygen which they disengage, serve to oppose or even arrest putrefaction. They rapidly remove nitrates and ammonia from water, since these two substances supply the nitrogen necessary to their growth; in the dark, however, liquids charged with these algæ evolve ammonia.

Prolification of Caulerpa.‡—Dr. J. H. Wakker has investigated this phenomenon in cultures of *C. prolifera* from the Bay of Naples, and finds that it may take place abundantly in each of the parts of the very large single cell which represent physiologically the rhizome, the roots, and the foliage of higher plants. In the "leaf" he has found as many as eleven successive prolifications in connection with one another. Dr. Wakker suggests that the production by *Caulerpa* of zoospores, which has very seldom been observed, is extremely rare, and that the chief mode of reproduction to which is due its very extensive growth, is this prolification. The author's researches are opposed to the conclusion of Sachs that the roots of plants grow only at their base, and buds at their apex, and that the direction is determined by the force of gravity.

Hildebrandtia and Dichosporangium.§—Herr R. Wollny has repeated his observations on the antheridia of *Hildebrandtia*, but suggests that when the mode of reproduction is fully known, it will be found that the plant described by him really belongs to *Peyssonellia*.

He also describes a new species of Ectocarpaceæ, *Dichosporangium Chordariæ*, with both unilocular and multilocular zoosporangia.

Hauck and Richter's Phycotheca universalis.—The first part is now issued of this very useful and valuable publication, consisting of dried specimens of fifty species of fresh-water and marine algæ, belonging to a great number of different orders.

Terrestrial species of Ulothrix.‖—M. E. de Wildeman describes in detail the two terrestrial species of *Ulothrix* (*Hormidium* Ktz.), *U. radicans* and *U. parietina*, especially the "radicles" characteristic of the former

* Malpighia, i. (1886) pp. 60–7.
† Ann. Agronom., xii. (1886) pp. 317–32. Cf. Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 1060.
‡ Versl. en Meded. K. Akad. Weten. Amsterdam, 1886, pp. 251–64 (1 pl.).
§ Hedwigia, xxv. (1886) pp. 125–32 (3 pls.). See this Journal, 1886, p. 659.
‖ Bull. Soc. R. Bot. Belg., xxv. (1886) pp. 7–18 (1 pl.).

species, which are insufficiently described and figured, and which appear to be the sole constant character by which the two species can be distinguished. He confirms Dr. Braxton Hicks' statement of the development of a *Ulothrix* or *Schizogonium* from a *Pleurococcus*. The radicles of *U. radicans* are replaced in *U. parietina* by branches.

Algæ of Bohemia.*—In the first part of this important work, Dr. A. Hansgirg treats of the general classification of Algæ. Excluding the Diatomaceæ, he adopts, in its main features, Rabenhorst's four classes of Rhodophyceæ, Phæophyceæ, Chlorophyceæ, and Cyanophyceæ. Under the Phæophyceæ he includes the Syngeneticæ (*Chromophyton* and *Hydrurus*), nearly allied to which are the Phæozoosporeæ (*Lithoderma*). The Chlorophyceæ he divides into Confervoideæ, Siphoneæ, Protococcoideæ, and Conjugatæ. The oogamic Confervoideæ are arranged under the families Coleochætaceæ (*Coleochæte* and *Herposteiron*), Œdogoniaceæ (*Œdogonium* and *Bulbochæte*), and Sphæropleaceæ (*Sphæroplea*); the isogamous Confervaceæ under Ulvaceæ (*Prasiola*, *Enteromorpha*, and *Schizomeris*), Chætophoraceæ (*Ulothrix*, *Stigeoclonium*, *Chætophora*, and *Draparnaldia*), Cladophoraceæ (*Conferva*, *Rhizoclonium*, and *Cladophora*, and Trentepohliaceæ (*Trentepohlia*, *Chlorotylium*, and *Microthamnion*). *Botrydium* he places under Siphoneæ.

In a separate paper,† Dr. Hansgirg enumerates the algæ found in the salt lakes and marshes of Bohemia. They are very numerous, and include representatives of nearly all the forms of Chlorophyceæ; but very few of the species are peculiar to these localities.

Structure of Diatoms.‡—Mr. H. Morland supports the view that in *Navicula Durrandii* the dots are nothing but minute perforations; but he cannot regard the median line or raphe as merely a thickening for strengthening the valve generally; he considers it, on the contrary, to be simply a cleft with thickened borders. In this species he has sometimes noticed, when examining the raphe, that it has two borders, in consequence of the cleft being slightly oblique, one of which, under a high power, will be seen to be on the "upper" surface, while the other is on the "inner" surface; but if the ends of these borders be examined, it will be found that they join each other. The same is the case in *Pleurosigma balticum*.

By the examination of carefully prepared sections of Jutland "cement-stein," § Mr. Morland confirms Prinz and Van Ermengem's statements with regard to the structure of the diatoms contained in it. The markings on the diatom-valves are seen to be perforations, although the structure differs in different forms. The author proceeds to describe the variations found in *Coscinodiscus oculus-iridis*, *Trinacria regina*, *Pyxidicula cruciata*, *Stictodiscus Jeremianus*, *Arachnoidiscus Ehrenbergii*, and *Aulacodiscus margaritaceus*. Of these he considers *Trinacria regina* to be one of the simplest, while the structure of *Aulacodiscus margaritaceus* is highly complicated; but in all the markings are seen, if carefully examined, to be perforations.

Lichenes.

Soredial sporidia of Amphiloma murorum.||—Sig. A. Borzì identifies the gonidia of this common wall-lichen with *Hormidium varium*. He describes a peculiar mode of reproduction of the soredia which he observed in very wet weather. Unicellular conidia from 2 to 4 μ in diameter were

* Hansgirg, A., 'Prodromus der Algenflora von Böhmen,' Heft 1, Prag, 1886. See Oesterr. Bot. Zeitschr., xxxvi. (1886) p. 313.

† Oesterr. Bot. Zeitschr., xxxvi. (1886) pp. 331-6.

‡ Journ. Quek. Micr. Club, ii. (1886) pp. 297-307. § See *infra*. Microscopy β.

|| Malpighia, i. (1886) pp. 20-4.

formed laterally or terminally on the hyphæ by the transformation of single hyphal cells, and detached themselves from the hyphal cortex of the soredium. These detached conidia readily germinated in the surrounding water. If the germinating filament came into contact with an isolated cell of *Hormidium*, it completely invested it, branching abundantly, the algal cell dividing at the same time, under the influence of the parasite, into four, eight, or sixteen, thus giving birth in a short time to a new soredium. If the germinating filament came into contact with a filament of *Hormidium*, the latter also became completely invested, and the cells of the filament separated and broke up into the coccus form, thus furnishing the gonidia for the new soredia.

Micro-chemistry of Lichens.*—Herr K. B. J. Forsell has tested a number of lichens and fungi for lignin by the phloroglucin and hydrochloric acid test, but in all cases with negative results. Some lichens, as *Lobaria pulmonaria* and *Lecanora pallescens*, took sooner or later a red tinge with indol and sulphuric or hydrochloric acid; but since the same result was obtained with potato-starch, gum arabic, cotton, and cane-sugar, this cannot be regarded as a reliable test for lignin. The author found that the hyphæ of lichens occasionally took a slight red tinge with sulphuric acid alone, without indol. This the author explained by the conversion of the lichenin into sugar by the acid, the sugar then giving Raspail's reaction with the acid in the presence of albuminoids.

Fungi.

Cell-nuclei in the Hymenomycetes.†—M. L. K. Rosenvinge has examined a large number of species of Hymenomycetes, with the object of determining the presence or absence of a nucleus in the cells. The staining reagent used was hæmatoxylin on material hardened in alcohol, but its use was often attended with difficulties.

The author finds that, as a general rule, all the cells of the Hymenomycetes contain nuclei, though, under certain circumstances, they may disappear with the protoplasm. In the adult cells of the ordinary hyphæ there are generally several nuclei; in the young cells there is probably only one, at least in some species. In the young basidia there is always only one. The cystidia also contain at first only a single nucleus, which may subsequently divide into several. A nucleolus can always be detected, especially in the nuclei of the basidia. In some genera the nucleus has a vesicular appearance, the chromatin accumulating at its periphery. The only case in which an indication of indirect division of the nucleus was observed by the author was in the basidia of *Tricholoma virgatum*. The nucleus of the basidia ordinarily divides into four or eight, double the number of the spores, which are formed all at the same time. The protoplasm and the nuclei pass from the basidium into the spores, which thus contain either one or two nuclei. If the spore contains only a single nucleus, its diameter considerably exceeds that of the sterigma. If it has two spores, these are smaller, their substance also being less dense. The change of form of the nuclei, in passing into the spores, is passive, being caused by the obstacle offered by the cell-wall of the sterigma.

The mode of formation of the spores in the Hymenomycetes is an example of cell-division. The two or four (rarely three or six) daughter-cells are formed in the lower part of the basidium or mother-cell, the

* SB. K. Akad. Wiss. Wien, xliii. (1886) pp. 219–30.
† Ann. Sci. Nat. (Bot.), iii. (1886) pp. 75–93 (1 pl.).

contents of which, protoplasm and nucleus, are entirely used up in the formation of the daughter-cells; nothing of the mother-cell remains except its wall.

Poisonous principles of Hymenomycetous Fungi.*—Herren R. Böhm and E. Külz find choline, the poisonous principle of *Amanita muscaria*, present also in *A. pantherina* and *Boletus luridus*, to the extent of 1 per cent. of the dry substance. In *Helvella esculenta* they found also an apparently identical base. In *A. pantherina* were found considerable quantities, in *B. luridus* much smaller quantities, varying with the season, identical in its properties with the muscarine of *A. muscaria;* the former species must be regarded as poisonous; *B. luridus* as suspicious, but often harmless.

In *Helvella esculenta*, which is frequently poisonous, the authors found a poisonous acid with the composition $C_{12}H_{20}O_7$, which they call *helvellic acid;* and in *B. luridus*, an acid to which they give the name *luridic acid*, easily obtainable in stable wine-red crystals, containing no nitrogen; it is probably the characteristic pigment of this fungus. In *A. pantherinus* was found a crystallizable acid of very similar composition, which the authors call *pantherinic acid.*

Schulzeria, a new genus of Hymenomycetes.†—Under this name Sig. S. G. Bresaloda describes a new genus of Agaricini belonging to the group Leucospori. It is distinguished from *Lepiota* by the absence of an annulus, presenting therefore a parallel genus to *Pluteus* and *Pilosaca.* In addition to the above, it is characterized by the absence of a volva, by the pileus being differentiated from the stipes, and by the lamellæ being rounded behind and quite free from the stipes. The author describes two species, *S. rimulosa* and *squamigera*, both from Slavonia.

Lycogalopsis Solmsii, a new Gasteromycete.‡—Under this name Herr E. Fischer describes the type of a new genus of Gasteromycetes gathered in Java by Graf Solms-Laubach. He places it between the Lycoperdaceæ and Hymenogastreæ, near to *Scleroderma.* The fructification has a peculiar laminated appearance, owing to the repeated cessation of growth of the weft of hyphæ of which it is composed; the denser portions of this weft not unfrequently inclose solid foreign bodies. The development of the gleba is described in detail. The spores are from 3 to 4 μ in diameter, of a nearly spherical or more irregular form, sessile or shortly stalked, 6–7 formed on each basidium, with a thick outer membrane; and they escape in the form of a fine powder when the rest of the gleba deliquesces. A rudimentary formation of capillitium is to be detected.

New Aspergillus.§—Dr. F. Morini describes a new species of this genus, or of *Sterigmatocystis*, which should probably be incorporated in it. It was found in a greenhouse, on *Ozonium auricomum*, forming bright blue spots just visible to the naked eye. Each of these spots consists of a bundle of filaments, from 105 to 150 μ in length, gradually narrowing upwards. Near the apex of each filament is a septum, and at the summit it branches into a nearly globular cluster of minute elliptical hyaline spores, about 4–5 μ long by 1·3–1·5 μ broad. These spores are arranged in chains springing from sterigmata 10–12 μ long, themselves seated on

* Arch. f. Expér. Pathol u. Pharmacol., xix. (1885). See Bot. Ztg., xliv. (1886) p. 642.

† Bresaloda, S. G., 'Schulzeria, nuove genere d'Imenomiceti,' 9 pp. and 1 pl., Trient, 1886.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 192–7 (1 pl.).

§ Malpighia, i. (1886) pp. 24–31 (1 pl.).

a kind of oval basidium, 7–8 μ long and 5–6·5 μ broad. The fungus was cultivated for several generations without producing any but the conidial form.

Diseases of Cultivated Plants.*—Dr. E. Rostrup has observed, in several places in the neighbourhood of Copenhagen, a hitherto undescribed fungus parasitic on barley, to which he gives the name *Scolecotrichum Hordei*, nearly allied to *S. graminis*. The disease takes the form of white strips on the leaves and stem. These strips are covered by fine grey dots which are masses of hyphæ projecting through the stomata. Each hypha bears a single, comparatively large, oblong, light yellow, bilocular conidium.

A *Rhizoctonia* was found to be a very widely spread enemy of clover, *Medicago sativa*, *M. lupulina*, *Rumex*, and *Geranium*. On clover plants from Norway a new species, *Typhula Trifolii*, was detected, and a *Rhizoctonia* on the potato.

Diseases caused by Fungi.†—Dr. E. Rostrup groups under the name "mycocecidia" the diseases of the nature of hypertrophy of tissue caused by parasitic fungi. As a general rule the Myxomycetes (*Plasmodiophora* and *Schinzia*) give rise to excrescences on the stem and roots. The Peronosporeæ cause curvature of the stem and patches on the leaves.

The author also describes the following new species:—*Physoderma deformans* on the flowers of *Anemone nemorosa; Taphrina Tormentillæ* on *Tormentilla erecta; T. Umbelliferarum* on *Heracleum Sphondylium* and *Peucedanum palustre; Fusarium amenti* on the catkins of *Salix cinerea* and *aurita;* and *Exobasidium Oxycocci* on *Oxycoccus palustris.*

Asteroma of the Rose.‡—Herr B. Frank describes the disease caused by this parasite in rose plantations, which differs from both the mildew and rust of roses. It manifests itself in circular dark greyish-brown spots, about 1 mm. in diameter, scattered over the whole upper surface of the leaf. The species is *Asteroma* or *Actinonema radiosum* Fr. It is distinguished by its radiating filaments which run beneath the cuticle, become septated and branched, and thence penetrate into the internal tissue of the leaf. The fructification is formed beneath the cuticle in the form of minute dark dots. The spores are from 0·015 to 0·018 mm. in length, two-celled and colourless, and germinate directly. The injurious effect of the parasite is shown in the formation of a brown or yellow resinous mass or of drops in the epidermal cells, the adjacent cells of the parenchyma also perishing. The disease sometimes extends to the under side, and the spores are very readily carried by rain or dew.

Gnomonia erythrostroma, a cherry-parasite.§—Herr B. Frank has investigated the cause of a disease which is exceedingly destructive to cherry-trees on the Lower Elbe, taking the form of yellow spots on the leaves, which gradually increase in number and size, causing the leaves to die without falling off, and finally killing the tree. He finds it due to the attacks of a parasitic fungus, *Gnomonia erythrostroma* Fkl. (*Sphæria erythrostroma* Pers.). The perithecia ripen in the spring, when the ascospores, of which eight are formed in each ascus, are violently thrown out of the asci in the same way as in *Chætomium*, this being the mode in which the

* In Danish, Copenhagen, 1886. See Bot. Centralbl., xxviii. (1886) p. 106. Cf. this Journal, 1886, p. 299.

† Bot. Tidsskr. Kjobenhavn, xiv. (1885) pp. 21–6. See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 99.

‡ Frank, B., 'Ueb. d. Rosen-Asteroma, einen Vernichter d. Rosenpflanzungen,' 1885 (16 pp. and 5 figs.). See Bot. Centralbl., xxvii. (1886) p. 294.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 200–5.

disease is propagated, the ejection taking place in wet weather only. *Gnomonia* furnishes another example of sexual reproduction among the Pyrenomycetes, the author having distinctly observed the production of the perithecia as the result of the impregnation of a trichogyne by spermatia in the same way as in *Polystigma*. The spermogonia are formed in the spongy parenchyma, the spermatia having the form, as in *Polystigma*, of long slightly curved threads. Several spermatia appear to impregnate a single trichogyne. The spores germinate at once, perforate the cuticle, and, penetrating the epidermal layer of cells, develope into a mycelium in the intercellular spaces of the mesophyll. By the infected leaves remaining on the trees after being killed by the fungus, the spread of the parasite is greatly promoted.

Orange-leaf Scab.*—Mr. F. L. Scribner describes the above disease, and suggests various remedies for arresting the malady. It first makes its appearance as small wart-like excrescences on the upper or under side of the orange-leaves. These excrescences increase in number and size, until the whole surface is covered, the vitality of the leaf becoming destroyed. Upon some of the diseased specimens there was discovered a species of *Fusarium*, believed to be identical with *F. sarcochroum* Desm., the tubercles being apparently caused by the mycelium of this fungus. The hyphæ and spores are present in greater or less abundance on all the more developed excrescences.

Peronospora viticola.†—Dr. P. Baccarini describes a peculiar disease which has recently attacked vineyards in the south of France, known as "negrone" or "negrara," and manifested in the drying up of the berries which still remain attached to their stalks. He attributes the malady to a peculiar development of *Peronospora viticola* and not, as has been generally supposed, to the attacks of the American "black-rot," *Phoma uvicola*.

Mode of Destruction of the Potato by Peronospora infestans.‡—Mr. E. W. Claypole states that in a potato the vascular layer appears as a semi-transparent line running along the cut surface about 1/4 in. below the cuticle, and rising to the eyes where it meets the layer that represents the bark. At these points the cuticle is exceedingly thin, and here the assault of *P. infestans* is usually made. Its progress is marked by a black streak advancing from the eye along the layer of vascular tissue. A layer of the bark immediately under the rind is attacked in the same manner. In these two layers the life of the potato resides, and their destruction consequently insures its death.

"Black-rot" of the Vine.§—MM. P. Viala and L. Ravaz describe a disease which has attacked vineyards in France since 1885, and which is identical with the American "black-rot" produced by *Phoma uvicola*. It attacks both the leaves and the berries, causing the latter to dry up and the skin to become covered with numerous pustules. These are produced by the conceptacles of the fungus, which are of two kinds; the larger are pycnidia containing stylospores, the smaller spermogones containing slender spermatia. While the "black-rot" is due exclusively to the attacks of *Phoma uvicola*, the diseases known in America as "grey-rot," "common-rot," "soft-rot," and "brown-rot" are all caused by *Peronospora viticola*. "Black-rot" has nothing to do with anthracnose, the identification of

* Bull. Torrey Bot. Club, xiii. (1886) pp. 181–3.
† Malpighia, i. (1886) pp. 56–60. ‡ Bull. Torrey Bot. Club, xiii. (1886) p. 191.
§ Viala, P., et L. Ravaz, 'Mém. sur une nouv. maladie de la vigne,' 4 pls., Montpellier, 1886. See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 129.

Phoma uvicola with a conceptacular form of *Glœosporium ampelinum* being erroneous.

The authors describe also three other parasites of the berry of the grape, *Phoma flaccida*, *P. reniformis*, and *Coniothyrium diplodella*, which have some analogy with "black-rot," but differ in causing no important injury.

Fungus of the Root of the Vine.* — Herr J. B. Schnetzler records for the first time the observation of fructification on the mycelium of *Agaricus melleus*, which is so common on the roots of diseased vines. The mycelium of *Dematophora necatrix* is also abundant in similar situations, and is not to be confounded with the former.

Fungi of Nova Zembla.†—In the collection of dried plants brought from Nova Zembla by M. Weber, Dr. C. A. J. A. Oudemans finds a large number of parasitic fungi, including the following new species:—*Pleospora Arctagrostidis* on *Arctagrostis latifolia*, *Leptosphæria Hierochloæ* on *Hierochloe alpina*, *Septoria Eriophori* on *Eriophorum angustifolium*, *Pleospora Cerastii* on *Cerastium alpinum*, *Leptosphæria Weberi*, *Sphærella nivalis*, and *Metasphæria Annæ* on *Ranunculus nivalis*, *Ascochyta Papaveris* on *Papaver nudicaulis*, *A. Drabæ* on *Draba alpina*, *Sphærella octopetalæ* on *Dryas octopetala*, *Sphærella Potentillæ* and *Microthyrium arcticum* on *Potentilla fragiformis*, *Phoma Astragali alpini* on *Astragalus alpinus*, *Phoma Polemonii* on *Polemonium pulchellum*.

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—Parts 22–26 of this work are still entirely occupied with the Sphæriaceæ, the principal genera described being *Mussaria* (27 sp.), *Gnomonia* (37 sp.), *Diarporthe* (132 sp.), *Valsa* (111 sp.), *Valsella* (18 sp.), *Anthostoma* (20 sp.), *Melanconis* (20 sp.), *Calosphæria* (18 sp.), *Diatrypella* (24 sp.), and a portion of *Hypoxylon*.

Protophyta.

Relationship of the Chlorophyllous Protophyta to the Protonema of Mosses.‡—Following out the observations of Hicks § on the relationship between the gonidia of lichens and certain stages in the development of the protonema of mosses, Dr. A. Hansgirg states that it is common to find, among the Chroococcaceæ and Palmellaceæ which are so abundant on the damp walls of hothouses, branched filaments of moss-protonema, some of the cells of which resemble externally the ordinary cells of the protonema, but the contents of which are strikingly different. Some of these cells, which may also be occasionally found in the open air, contain chlorophyll-grains of a pale yellow-green colour and undefined outline imbedded in yellowish-green cytoplasm; while in others the chlorophyll-grains had entirely disappeared, and the entire cytoplasm assumed a uniform golden colour, owing to the presence of drops of a fatty oil. By pressure or the resorption of the cell-wall these cells may be set free, and may lie isolated in the surrounding mucilage. Microchemical reactions indicate that the contents probably consist partly of a fatty oil, partly of reduced chlorophyll. Such isolated cells commonly still retain their cylindrical form, and bear a close resemblance to *Cylindrocystis*. In some of these cells the author observed the green pigment more or less collected in the centre of the cell, while in others were two eccentric nucleus-like bodies or well-

* Bot. Centralbl., xxvii. (1886) p. 274.
† Versl. en Medded. K. Akad. Weten. Amsterdam, 1886, pp. 146–62 (3 pls.).
‡ Flora, lxix. (1886) pp. 291–303.
§ Quart. Journ. Micr. Sci., 1861; Trans. Linn. Soc. Lond., 1862; and Trans. R. Micr. Soc., 1864, p. 257.

developed star-shaped chromatophores with distinct globular pyrenoids. They bear a very close resemblance to the *Mesotænium* form of *Palmoglœa* in the condition in which the cells are found after long-continued dry weather. Between these cells and the ordinary cells of the moss protonema are all grades of transition.

This retrogressive metamorphosis of the protonema occurs with several species of moss, especially when growing in moist slimy situations. Under favourable conditions the cells are capable of vegetative bipartition, commencing with the pyrenoids and chromatophores. It has been pointed out by Schmitz * that pyrenoids occur as low down as the Anthoceroteæ, and by the present author † that they are found in the Phycochromaceæ when in a state of retrogressive metamorphosis, but not when in the ordinary filiform condition.

The general conclusions drawn from these observations by the author is that the Phycochromaceæ must no longer be regarded as the primitive form of algæ, their half-saprophytic mode of life and the occurrence of highly organized substances imbedded in their protoplasm indicating their true position as derivatives from higher forms of life by retrogressive metamorphosis.

Acanthococcus.‡—Herr P. F. Reinsch gives a full description of this genus of Palmellaceæ, founded by Lagerheim on Reinsch's *Pleurococcus vestitus.* Fourteen species are described, twelve of them new, obtained from gatherings in Germany, Scandinavia, and the United States. They appear to be extremely abundant in fresh water among larger algæ, and are probably generally mistaken for the zygospores of desmids, though often to be seen at periods of the year when these are not to be met with. The structure and biology of *Acanthococcus* differ but little from those of *Palmella.* The perfect cell divides into 8–16 daughter-cells, which remain but a short time in connection, being set free by the deliquescence of the outer membrane. After this breaking up, the gelatinous outer layers of the daughter-cells undergo a variety of changes, developing into warts, spines, and other prominences characteristic of the genus and of the different species; this being their resting condition. After hibernation these divide into 4–8–16 daughter-cells with smooth walls. They are best distinguished from the zygospores of desmids by the nature of their cell-wall, and by containing, when mature, coloured drops of oil instead of vacuoles of water.

Sphærogonium, a new genus of Phycochromaceæ.§—Dr. J. Rostafinski describes seven species of this new genus nearly allied to *Chamæsiphon*, but differing from it in being unicellular. These two genera, together with *Clastidium* and *Dermocarpa*, make up the family Chamæsiphoneæ.

New Hæmatococcus.‖—Dr. F. Blochmann describes a new species of this genus to which he gives the name *Hæmatococcus Bütschlii*, corresponding in the main in its history of development to *Chlamydomonas.* It differs, in the swarming condition, from *H. pluvialis* in having no distinct chromatophore, and in possessing numerous much-branched pseudopodia of a uniform green colour. In the centre of the protoplasmic body is the

* See this Journal, 1883, p. 405. † See this Journal, 1885, p. 691.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 237–48 (2 pls.). Cf. this Journal, 1884, p. 273.

§ R. i. S. Akad. Krakau, x. (1883) pp. 280–305 (1 pl.). See Bot. Centralbl., xxvii. (1886) p. 352.

‖ Ber. Heidelberg. Med. Naturh. Ver., 1886 (22 pp. and 2 pls.). See Bot. Ztg., xliv. (1886) p. 676. Cf. this Journal, 1886, p. 1006.

nucleus, with two pyrenoids, one before and one behind it. At the anterior end is a conspicuous crescent-shaped red "stigma." At the anterior pole are also two vibratile cilia projecting through small tubes in the membrane.

Vegetative division takes place in the night, the contents dividing first into two and then into four, the pseudopodia being withdrawn. The four daughter-cells then surround themselves each with a delicate cell-wall, and each developes two cilia, the cilia of the original individual still remaining attached to its membrane after the daughter-cells escape from it. The stigma of the original cell occupies a posterior position in one of the daughter-cells, the stigmas not being developed in the others till after their escape. A reversal of the poles and of the direction of movement takes place on each division.

The formation of microgonidia takes place in the latter part of the day, the first stages of the process being the same as in vegetative division, but the bipartition continues until 32 or 64 distinct bodies are formed, the stigma eventually entirely disappearing. The microgonidia thus formed are about 1/10 the size of the ordinary swarming cells; they are pear-shaped or fusiform with a hyaline anterior and pale green posterior end; at the former end is an obscure stigma and two cilia; they have no membrane. Conjugation takes place as soon as they escape from the mother-cell, and microgonidia from the same mother-cell may unite; they lose their cilia and develope a cell-wall of cellulose. The resulting resting-cell acquires a red colour from the formation of hæmatochrome, and remains dormant during the winter; in the spring the whole contents escapes from the membrane, excretes a cell-wall, and developes into a normal swarming cell with two vibratile cilia.

Spore-formation in Yeast.*—Herr A. Zalewski has investigated spore-formation in *Saccharomyces ellipsoideus* Rees, *S. apiculatus*, and *Mycoderma vini*. After the cells have been left twenty-four hours in water, they cease to be very refringent, and become finely granular. The protoplasm collects on the walls, afterwards shrinks up at one point, and gathers on either side of this. It incloses black points which the author regards as developing nuclei. These, however, soon disappear, and the two masses increase rapidly, rounding themselves off and forming a membrane. In *Mycoderma vini* the nuclei are more evident, and the spore-formation again takes place by division of the protoplasm. In the vegetative forms the nuclei can be readily demonstrated by placing the cells in water for some hours, and then treating them with hæmatoxylin and alum solution.

Detection of "wild yeast" in low yeast.†—Herren J. C. Holm and S. V. Poulsen have determined by experiment the minimum quantity of "wild yeast"—giving a bitter taste to the wort without causing fermentation—which can be detected in the "low yeast" of *Saccharomyces cerevisiæ*. The mode of recognition employed was Hansen's, viz. the formation of ascospores; and the authors found that even as small an admixture as 0·5 per cent. could be detected in this way, the "low forms" used being *S. Pastorianus* and *ellipsoideus*. With an admixture of from 1 to 2 per cent. of "wild yeast," ascospores begin to be formed in 30 hours, and are abundant in 40 hours.

Acetous Fermentation.‡—Sig. A. Romegialli states, as the result of a number of experiments, that the growth of the acetous ferment is increased

* Arch. Slav. de Biol., ii. (1886) p. 293, from Ann. Acad. Sci. Cracovie, 1885.
† Medd. Carlsberg Lab., ii. (1886) pp. 147–5. See Bot. Centralbl., xxvii. (1886) p. 231.
‡ Gazzetta, xvi. (1886) pp. 73–101.

by the presence of glycerol and of succinic and malic acids, of which the first is the most readily assimilated; secondly, asparagin is more favourable than albumin, whilst ammonium chloride and phosphate are not convenient media for furnishing the requisite nitrogen. The presence of sulphur, silica, and iron are useful, if not indispensable, to the ferment.

Mycoderma aceti (?) contains 71·3 per cent. of a substance showing all the reactions of cellulose; the remainder consists of albumin, fatty substance, and ash (4·4 per cent.), the last consisting of chlorine, and silicic, sulphuric, phosphoric, and carbonic acids, combined with potash, soda, lime, magnesia, and ferric oxide.

Lactic Fermentation.*—Herr G. Marpmann remarks on the very contradictory views still prevailing as to the nature of lactic fermentation. During the past summer he has investigated the micro-organisms of cows' milk in the neighbourhood of Göttingen, and has detected five seemingly new and different species, which more or less strongly induce lactic fermentation in cane sugar as well as in milk. Coagulated milk filtered, mixed with 10 per cent. of pure gelatin, was employed as a medium for the cultivation of the above.

Fate of Microbes in the Blood of Warm-blooded Animals.†—Experiments by Herr W. Wyssokowitch show that both the spores of fungi (*Aspergillus*, *Penicillium*, &c.) and bacteria disappear very rapidly from the blood of warm-blooded animals. Of saprophytic bacteria injected into the blood of animals, not a trace was visible, after three hours, of *Bacillus subtilis*, *B. acidi lactici*, *Micrococcus aquatilis*, or *Spirillum tyrogenum*. Of those which are pathogenic to man, *Micrococcus tetragonus*, *Bacillus typhi abdominalis*, *Spirillum choleræ asiaticæ*, and *Streptococcus pyogenes*, disappeared in from 3 to 4½ hours. Those which are pathogenic to the animal experimented on of course increase rapidly in numbers till its death.

The microbes which disappear do not pass from the blood into the kidneys or entrails. The author believes that they find their fate chiefly in the endothelial cells. Between these cells and the bacteria there is a constant warfare. Either the former conquer and the bacteria perish, or the cells are themselves destroyed by the bacteria, in which case the microbe is pathogenic for the animal in question.

Influence of Desiccation and Temperature on Comma-Bacilli.‡—Herr L. Lenevitch finds that desiccation at the ordinary temperature is always fatal to the comma bacilli of Koch. In a fluid medium the effects vary considerably. Thus at 60° C. the vitality is reduced, while at 70° the bacteria are killed in half an hour or an hour. A few minutes' exposure to a temperature of 100° is fatal. The author emphasizes the extreme difficulty of securing desiccation and uniform diffusion of heat. He regards at least 100° C. as effective for the destruction of comma bacilli in a fluid medium.

Bacterium maydis.§—Prof. G. Cuboni believes that "pellagra" is, like cholera, the result of the excessive development of an intestinal *Bacterium*. He has lately investigated the characteristics of this *Bacterium* (*B. maydis*).

1. In gelatin cultures in contact with air, the colony appeared first in the form of minute white spots, which gradually increased, dissolving the

* Arch. Pharm., xxiv. (1886) pp. 243–56. See Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 733.

† Zeitschr. f. Hygiene, i. (1886) pp. 1–45. See Bot. Centralbl., xxvii. (1886) p. 263.

‡ Arch. Slav. de Biol., ii. (1886) pp. 306–7, from Vratch No. 8, 1886.

§ Atti R. Accad. Lincei—Rend., ii. (1886) pp. 532–5 (2 figs.).

gelatin and forming a compact spherical mass. When not in contact with air, the colony remains as small points, forming a slight opaque turbidity, which increases till it unites and the whole of the gelatin is dissolved internally.

2. In a pure culture, in a tube containing gelatin and maize flour digested with diastase, the colony assumed a funnel-like form, at the foot of which there is always a nucleus of white substance.

3. The form of *Bacterium maydis* is not constant. The long bacillar type, 3 μ long by 1 μ broad, segments into much smaller elements, like true bacteria, and resembling grains of rice, which finally divide into still minuter pieces, like micrococci, only more elliptical. The nuclei of spores were observed.

"Foul-brood" of Bees.*—Dr. Ciesielski describes the mode in which this disease is caused by the newly discovered *Bacillus Preussii.* It developes in the intestinal canal of the larva, destroying the entire body by its rapid increase. In each bacillus are formed four spores towards the end of its development, which germinate only within the bee, and develope again into the bacillus.

Intestinal Bacteria.†—Herr T. Escherich proposes to include under the term *Helicobacterium*, all forms characterized by the absence of endogenous spores, the power of swarming, the transformation, under certain conditions, of filamentous, short-rod, and coccus forms, into spiral and zooglœa-forms, the excretion of a ferment which dissolves solid albumen and coagulates the casein of milk, and which occur on animal nutrient substances and in the intestinal canal. The group would include Hauser's *Proteus vulgaris*, Kurth's *Bacterium Zopfii*, and a microbe found by the author in the contents of the intestines.

This organism was met with in the intestinal canal of guinea-pigs, on imperfectly sterilized fibrin, and in the intestines of a dog fed on meat. On a gelatin-plate it appeared as a delicate pellicular colony from which a number of beautifully coiled spirals penetrated the gelatin. On a new plate the surface was, after twenty-four hours, covered with dry scales, while within the gelatin were much-branched and coiled colonies. Under the Microscope, pointed or fusiform zooglœa-colonies were seen to proceed from round yellowish balls, often running out into long beautiful spirals. This peculiar appearance arises in the following way.

From an interior spherical colony springs a delicate, at first only slightly coiled, thread, which becomes coiled from the thread growing more rapidly than its apex penetrates into the gelatin. Dense agglomerations are formed, especially at the parts near the point of exit; and these coalesce into moniliform expansions, and develope into the coiled and fusiform zooglœa-colonies. By the rapid development of these formations the substance of the gelatin becomes covered by a branched system of zooglœa-colonies, connected by countless anastomoses. Between the meshes of this network are numerous groups of swarming bacilli, spirulinæ, and coiled threads. The movement of the bacilli is not so active as that of *Proteus vulgaris.*

The coloured cover-glass preparation shows roundish or elliptical forms grouped in various ways. They are usually combined into diplococci, though also in tetrads, small groups, or chains. The round forms have a diameter of not quite 1 μ; they are stained uniformly and intensely by anilin. The zooglœa-colonies are composed either of large cylindrical bacilli, 0·9 μ broad and 3–10 μ long, or of long parallel filaments, some of

* In Polish, 1884. See Bot. Centralbl., xxvii. (1886) p. 346.
† Münch. Med. Wochenschr., xxxiii. (1886). See Bot. Centralbl., xxvii. (1886) p. 228.

which are of enormous length. After the fourth day the filaments and rods break up into smaller and smaller fragments, resulting in chains of diplococcus-like structures, which finally separate into cocci. In this state, corresponding to the spore-condition of the endosporous forms, they may preserve for a long time their vitality and power of development. Macroscopically, the cultures agree almost entirely with the contagium of syphilis, described by Klebs under the name *Helicomonas syphiliticum*.

Contagium of Lung-disease.*—Herren J. Poels and W. Nolen find, in all cases of fresh lung-disease, a particular micrococcus constantly present in the lungs, and in the exudation in the pleural cavity, which can be readily cultivated. It occurs both as coccus and diplococcus, occasionally as triplococcus, or there may be as many as six arranged in a chain. The coccus is nearly or quite spherical, with a diameter of about $0 \cdot 9\ \mu$, but varying between $0 \cdot 8$ and $1 \cdot 1\ \mu$. Uncoloured preparations from the lungs and from the pleural exudation showed some invested with an evident envelope like Friedländer's *Pneumonicoccus*, from which, however, it was distinguished by a higher receptivity for pigment, being coloured by all the anilin-pigments.

From the facts that this coccus is always absent from the lungs of sound cattle; that it is always present after inoculating with lung-disease; that, when cultivated in pure cultures, it can be used for inoculation, causing pulmonary changes in cattle a few days after infection, the authors conclude that it is itself the contagium of lung-disease.

Swine-fever.†—Dr. Löffler describes the microbe which always accompanies this disease, in the form of delicate rods similar to those of Koch's septicæmia of mice, but somewhat shorter and slightly thicker. With Weigert's picrocarmine-gentian-violet double staining they take an intense black-blue colour, and are then readily seen in the pink tissue. By Gram's method they are still more easily rendered visible. Cultures in various nutrient fluids produced only the one kind of bacterium, closely resembling that of the septicæmia of mice. In one instance small ovoid bacteria were obtained, and the author concludes that probably two distinct but similar diseases are included in the term "Rothlauf."

Dr. Löffler's results are in essential points confirmed by Dr. Schütz.‡ He finds that, in contrast to pigeons, fowls are not receptive to the virus of the swine-fever. He regards the disease as identical with the French "rouget des porcs."

Swine-fever.§—The description of the microbe of this disease by Drs. A. Lydtin and M. Schottelius agrees in its main features with that of Löffler,|| except that they speak of the bacilli as somewhat larger and as apparently forming spores. For staining they use Gram's gentian-violet-iodine pigment, with secondary staining by a dilute aqueous solution of vesuvin. It is found in all the organs of infected animals, especially the kidneys, liver, spleen, and lymphatic glands, particularly in those of the intestinal canal. In cases of spontaneous disease, the authors noticed in addition a longer, thicker, motionless bacillus, forming rows of spores which have the peculiarity of germinating, not in the direction of the rod, but at right angles to it. They believe, however, that the former is the true

* Fortschr. d. Med., iv. (1886). See Bot. Centralbl., xxvii. (1886) p. 230,

† Arbeit. K. Gesundheitsamte, Berlin, i. (1885) pp. 46–55. See Bot. Centralbl., xxvii. (1886) p. 297.

‡ Ibid., pp. 56–76 (7 pls.). See Bot. Centralbl., xxvii. (1886) p. 324.

§ Lydtin, A., u. Schottelius, M., 'Der Rothlauf d. Schweine,' 254 pp. and 23 pls. Wiesbaden, 1885. See Bot. Centralbl., xxvii. (1886) p. 298.

|| See *supra*.

bacillus of swine-fever, and they found it fatal to mice, rabbits and pigeons, but not to white or wild rats, dogs, or fowls.

Necessity of Oxygen for Bacteria.*—Dr. P. Liborius publishes the results of a series of experiments on the degree to which various bacteria can carry on their vital functions under partial or entire exclusion of oxygen. Of a variety of methods employed for excluding oxygen, the most efficacious was found to be the replacement of the air by aqueous vapour or by hydrogen; almost as good results were obtained by the superposition of a thickness of 3 cm. of a solid nutrient substance. The nutrient employed was extract of meat peptone-gelatin with 5, 7, or 10 per cent. of gelatin, and 1 per cent. of agar-agar.

Some bacteria were found to be very indifferent to the exclusion of oxygen; these were especially *Bacillus acidi lactici*, *Proteus vulgaris*, *Streptococcus pyogenes*, *Bacillus pneumoniæ*, *B. crassus sputigenus*, *B. prodigiosus*, and *B. murisepticus*. The growth of *Staphylococcus aureus*, *B. typhoidei-abdominalis*, *Spirillum choleræ-asiaticæ*, *S. tyrogenum*, and *S. Finkleri* was also not completely arrested by deprivation of oxygen. Other species showed under these circumstances a change in their biological properties, a loss of some characteristics, or an arrest of growth. But the degree of deprivation of oxygen necessary for these changes varies with the different species.

The property first affected is the production of pigment, for which contact with free oxygen is necessary. It follows that the bacteria can produce only a chromogenous substance which is converted into a pigment by oxidation. The power of peptonizing is also soon affected; but this varies, even when the supply of oxygen is abundant, according as the nutrient substance contains sugar or not. With the cholera-spirillum deliquescence is prevented by the entire elimination of oxygen; while with *Bacillus prodigiosus* and *Proteus vulgaris* it is only retarded under these circumstances. The fermenting power of bacteria also depends largely on the composition of the nutrient substance. *Bacillus aerophilus* appears to be the species most dependent for its development on the presence of oxygen.

A number of anaerobes were isolated by cultivation on solid substrata, and the following specially described:—1. *Bacillus œdematis-maligni;* bacilli 3 μ long, 1 μ broad, often growing into long threads; spores not in threads, but in single fusiform bacilli. 2. *Clostridium fœtidum;* bacilli 1 μ broad, varying in length, actively motile, often in pseudo-filaments; spores usually in the middle of the swollen filament, but also towards the ends, oval, strongly refractive. 3. *Bacillus polypiformis;* bacilli slender, more than 1 μ broad, varying in length, with no tendency to the formation of threads; spores oval or cylindrical, often occupying one-half to one-third of the filament. 4. *B. muscoides;* bacilli slowly motile, with slight tendency to the formation of threads; spores roundish oval, mostly terminal, strongly refractive. 5. The pseudo-œdem bacilli; found in company with the œdem-bacilli, thicker than they, surrounded by a light border, usually with two spores in each bacillus. They are pathogenic, apparently in consequence of the formation of a ptomaine.

Bacteria in Drinking-water.†—Herr M. Bolton finds that certain bacteria exist in ordinary spring water, and are capable of multiplication in it. Among these two may be specially mentioned: *Micrococcus aquatilis*, which occurs as cocci collected into small irregular heaps, and *Bacillus*

* Zeitschr. f. Hygiene, i. (1886) pp. 115–77 (2 pls.). See Bot. Centralbl., xxvii. (1886) p. 198.

† Zeitschr. f. Hygiene, i. (1886) pp. 76–114. See Bot. Centralbl., xxviii. (1886) p. 16.

erythrosporus, distinguished by its spores having a reddish sheen, and the production of a greenish pigment without any deliquescence of the gelatin in which it was cultivated. Both these bacteria multiply to an enormous extent in water, the quality of the water and the amount of organic and inorganic substances contained in it appearing to have no effect on the reproduction, which is, however, materially promoted by an increase of temperature. These bacteria were found in most examples of spring water, and appear to originate chiefly from the surface of the neighbouring soil. These bacteria are not pathogenic.

The author found, on the other hand, that pathogenic bacteria, when introduced into spring water, never multiply, but disappear after a time, varying in length according to the species and the temperature. He concludes that the quantity of bacteria present in spring water is no guide whatever for the wholesomeness or otherwise of the water for drinking purposes, since these are mostly entirely harmless; and that it is impossible, by chemical analysis, to determine the presence of bacteria in larger or smaller numbers.

Chemical Composition of Bacillus anthracis.*—Dr. M. Nencki states that analysis of pure spore-material of *B. anthracis* gives only traces of mycoprotein, the principal ingredient being a proteinaceous substance nearly allied to mucine, soluble only in alkalies, which he calls mycomucine. The pathogenic properties of the bacillus are not due to the prepresence of a poisonous alkaloid, but to its direct action in destroying the living protoplasm of the cell.

Distribution of Micro-organisms in Air.†—The experiments undertaken by Dr. P. F. Frankland were conducted by means of Hesse's method of solid culture media. The apparatus employed consisted of (*a*) a tube, lined by Koch's gelatin peptone, through which a known volume of air could be drawn, and of (*b*) circular dishes containing the same substance, and employed to ascertain the number of micro-organisms falling on a given surface during a definite time. The apparatus is described and figured.

Experiments were made on the roof of the Science Schools, South Kensington; on St. Paul's Cathedral; in rooms, railway carriages, &c., and in the country.

Tables are given showing the place, conditions, number of organisms per volume of 10 litres of air, and number falling on a square foot per minute. From these it is found that in cold weather the number of organisms in the air is very much smaller than during summer, even after rain. Thus, at the top of the Science Schools, with snow on the ground, there were only 4 per 10 litres of air; on a cold, windy day, 433 per square foot fell in a minute. After exceedingly heavy rain, 40 per 10 litres were found to be present in the air. The average of these experiments show 35 per 10 litres, or 279 per square foot.

Of the experiments in the country the average showed 14 per 10 litres and 79 on a square foot per minute. The air in gardens was found to be higher than in the surrounding country.

Of the experiments in Hyde Park, &c., the number of micro-organisms is intermediate between the above two situations; on an average there were 24 per 10 litres of air, and 85 fell on one square foot per minute.

From the experiments made at different altitudes on Norwich Cathedral and St. Paul's, the author finds that the number of micro-organisms decreases

* In Polish, 1884. See Bot. Centralbl., xxvii. (1886) p. 347.
† Proc. Roy. Soc., xl. (1886) pp. 509–26 (3 figs.).

with the altitude. Thus, on the Golden Gallery, St. Paul's, on the Stone Gallery, and in the churchyard, the numbers respectively were, on one occasion, 11, 24, 70 per 10 litres of air. The average at the base of St. Paul's is greater than the average for the South Kensington experiments. The average at the top closely approaches, but is less than the average in the country. In inclosed spaces the number of suspended organisms is very moderate, so long as there is no aerial commotion, but as soon as the air is disturbed the number rises rapidly; as is already known. Thus in a quiet room, 44 micro-organisms fell on one square foot per minute, but with 20 people dancing this number was increased to 400.

In a railway carriage with ten passengers, as many as 3120 fell on a square foot per minute.

Multiplication of Micro-organisms.*—Dr. P. F. Frankland gives the results of his experiments on the multiplication of micro-organisms found in the unfiltered waters of the Thames and Lea, in the filtered water derived from these sources, as supplied by the water companies of London, and in water from deep wells. The author used Koch's method of plate cultivation with peptone gelatin. The apparatus is described in a previous paper,† but distilled water is substituted for mercuric chloride in the moist chamber.

He finds that all these waters contain abundant micro-organisms, the number of which, however, varies considerably. The crude water of the Thames and Lea usually contains thousands per cubic centimetre, whilst in deep well water the number is reduced to 10.

Tables are given showing the multiplication under various conditions, e. g. frost, daylight at 20° C., darkness at the same temperature, &c., during various lengths of time. There is a tendency for the number of micro-organisms to be reduced in number if kept at 20° C., whereas an incubating temperature of 35° C. causes a rapid increase. The number found in filtered water is only about 5 per cent. of that in the unfiltered river water. The micro-organisms in filtered water left standing for 24 hours, even in cold weather, undergo a slight increase in number, which is greatly increased if they are kept in a refrigerator for a longer period. It seems that the organisms in this water multiply at 20° C. at a much greater rate than those in unfiltered water.

In the case of deep well waters, the organisms have little tendency to multiply in the cold; but at 20° C. far exceeds that in the other waters.

The author infers from this rapid multiplication, and from the fact that at the outset the well water is nearly free from micro-organisms, that the little nutriment necessary for the purpose has been wholly untouched; whilst in river waters it has been attacked by numerous generations of micro-organisms. The number of different varieties is much greater in the latter case than in the former, so that in these well waters the micro-organisms have little or no competition.

The second part of the paper deals with pathogenic organisms, more especially with their multiplication when purposely introduced into the various waters. The three forms studied are *Bacillus pyocyaneus*, Finkler-Prior's *Comma spirillum*, and Koch's *Comma spirillum;* and the nature of the growth in the cultivating medium is described.

The author draws attention to the fallacy of the conclusions drawn as to the vitality of pathogenic bacteria in general. Each individual organism must be made the subject of separate investigation. Any initial weakness

* Proc. Roy. Soc., xl. (1886) pp. 527-44 (3 figs.).
† See this Journal, 1885, p. 923.

of growth renders it less capable of withstanding the conditions of experiment. Hence the discrepant results of various observers on antiseptic action.

Reduction of Nitrates by Micro-organisms.* — MM. U. Gayon and G. Dupetit contribute a biological study of certain denitrifying microbes by the method of cultures, an examination of the products and mechanism of the chemical reactions which they provoke, and a discussion of the agricultural application of the phenomena.

The reduction of nitrates to nitrites is brought about by many different microbes; but this memoir is devoted especially to an account of two which, in the presence of organic matter, decompose nitrates with production of nitrogen and nitrous oxide. These two microbes were obtained by the authors from sewage; and they have isolated and studied them by systematic cultures in sterilized liquids under various conditions.

Bacterium denitrificans α, the more active of the two, is 0·4 to 0·6 μ broad by 2–4 μ long, of feeble refraction, and outlines not clearly visible except in stained preparations. They are in very active motion in liquids containing nitrates, and multiply by fissiparity during the first days of development; afterwards 1–3 spores form in each individual. *B. denitrificans* β differs little under the Microscope from the preceding; it is a little larger and more refractive. These two bacteria are best distinguished by the rate of their development and by the products of their action on nitrates under comparative cultures in the same medium. They are best stained by methyl-violet and by gentianin. A sterilized liquid sown with *B. denitrificans* α evolved gas after eighteen hours. By exact analyses of the evolved gases, and of the fermented liquids, the authors show that the whole of the nitrogen of the nitrate is evolved as gas, and that the whole of the oxygen of the nitric acid is combined with the carbon of the organic matter to form carbonic anhydride. Organic matter is essential to the reaction; 1 gram of nitre requires 0·148 gram of carbon or 0·273 gram of albuminoid matter for its complete decomposition. Denitrification is accompanied by a very considerable rise of temperature—in meat infusions 5°·45, and in the artificial medium 10°. The destruction of nitrates by soil observed in Schloesing's experiments is explained by the authors as the work of bacteria similar to those with which they experimented.

Hüppe's Bacteria.†—In this important work the different forms of Schizomycetes, their development, and their relationship to one another, are treated of in great detail. The same species may occur under three different forms, which are, of course, not sharply differentiated from one another, viz. (1) The coccus form, including all isodiametric, spherical, or only slightly elongated ellipsoidal cells; (2) the rod-form, with distinct elongation in one direction; and (3) the spiral form, spiral rods, which can, however, on superficial observation, be readily seen to be curved rods. He regards the presence of true protoplasmic vibratile cilia as no essential condition for spontaneous movement; the structures hitherto described under this name probably vary in morphological and physiological value.

As a classification of "genera" and species of Schizomycetes, Dr. Hüppe proposes the following:—A. Bacteria with formation of endogenous spores: 1st genus, Coccaceæ, with subgenera Streptococcus (?) and Leuconostoc(?); 2nd genus, Bacteriaceæ, with subgenera Bacillus and Clostridium; 3rd

* Station Agron. de Bordeaux, Nancy, 1886. See Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 823.

† Hüppe, F., 'Die Formen d. Bakterien u. ihre Beziehungen zu d. Gattungen u. Arten,' 152 pp. and 24 figs., 8vo, Wiesbaden, 1886.

genus, Spirobacteriaceæ, with subgenera Vibrio and Spirillum. B. Bacteria with formation of arthro-spores (including those the mode of fructification of which is not yet known): 1st genus, Arthro-coccàceæ, with subgenera Arthro-streptococcus, Leuconostoc, Merista, Sarcina, Micrococcus, and Ascococcus; 2nd genus, Arthro-bacteriaceæ, with subgenera Arthro-bacterium and Spirulina; 3rd genus, Arthro-spirobacteriaceæ, with subgenus Spirochæte; 4th genus, Leptothricheæ, with subgenera Leptothrix, Crenothrix, and Phragmidiothrix (?); 5th genus, Cladothricheæ, with subgenus Cladothrix.

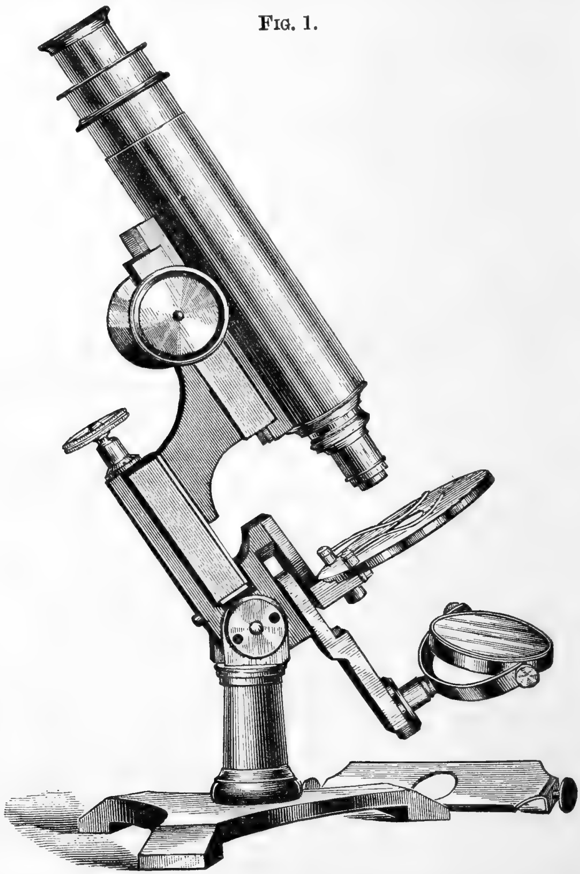
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Bulloch's Student's Microscope.—In this instrument, by Mr. W. H. Bulloch, of Chicago (fig. 1), the stage is connected with the stem by means

Fig. 1.



* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

of a strong angle-piece, leaving space for the free movement of the radial swinging tail-piece. The arrangement is a modification of the plan adopted some time ago by Mr. Bulloch, to remedy the flexure so commonly found in the Zentmayer mechanism, where the stage is carried by a conical spindle passing through a sheath in the lower end of the stem, the swinging tail-piece fitting by means of a collar outside the sheath.

Bausch & Lomb Optical Co.'s Combined Inverted and Vertical Microscopes ("Laboratory" and "University" Microscopes).—The Inverted Microscope, in the forms issued by M. Nachet, is well known to microscopists. The Bausch & Lomb Optical Co. have now combined it with the ordinary vertical form, the principle involved being, they believe, entirely new. "There is no question that the fact that the inverted could only be used as such, and that it was but incomplete at the best, has precluded its more general use, and we have no doubt that offering them as we do now by combining two instruments in one, and supplying each with such complete adjustments as modern requirements demand, they will be found to fill a necessity in certain branches and prove a great convenience in others. . . . This form of instrument is particularly adapted for chemical investigations, for the reason that crystals may be studied as they lie in their natural position in any depth of fluid, and the head is sufficiently distant from the stage not to inhale any fumes. Further than this, it is valuable in the examination of diatomaceæ and other objects in water which are heavier than it, and therefore sink to the bottom; also in moist histological preparations, as they adhere to the surface of the slide, and are therefore in one plane. It is also an excellent dissecting Microscope, as it is partially erecting, offers no hindrance to manipulation with any power, and makes it convenient to observe the object directly." *

There are two forms, the "Laboratory" and the "University."

The "Laboratory" Microscope when used as an inverted instrument, is shown in fig. 2. The mirror-bar swings on an axis in the plane of the stage to any point above or below it. The mirror and substage are adjustable on the mirror-bar. The substage carries a revolving diaphragm, and is fixed on a pivot so that it will swing in and out of the optic axis, allowing the polarizer to be attached and ready for instant use. On the slide is the arm, to the lower side of which is fastened the prism-box. On the upper horizontal surface of this is the nose-piece, with an extra adapter for high powers, and in the oblique surface is a screw-socket for the body-tube.

To transform the instrument into an ordinary Microscope, fig. 3, the tube is unscrewed, the milled head at the front of the arm loosened, which releases the prism-box, and the arm is swung on its axis from between the pillars into an upright position. The tube is now attached to the opposite side of the nose-piece, and after the stage clips are reversed it is ready for work.

The "University" Microscope (figs. 4 and 5) is in its general construction similar to the preceding, except that the (single) pillar and the arm are not japanned but are of brass, and that the instrument swings on an axis which is the same as that of the mirror-bar. The stage consists of a glass plate mounted in a brass ring.

The prism used for inversion is that suggested by Mr. J. Lawrence Smith

* 'Illustrated Catalogue of Microscopes, Objectives, and Accessories,' 10th ed., 1886, p. 33.

Fig. 2.

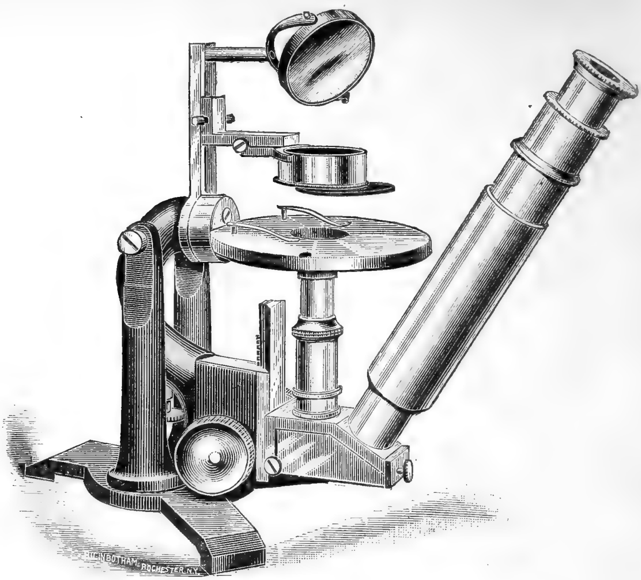


Fig. 3.

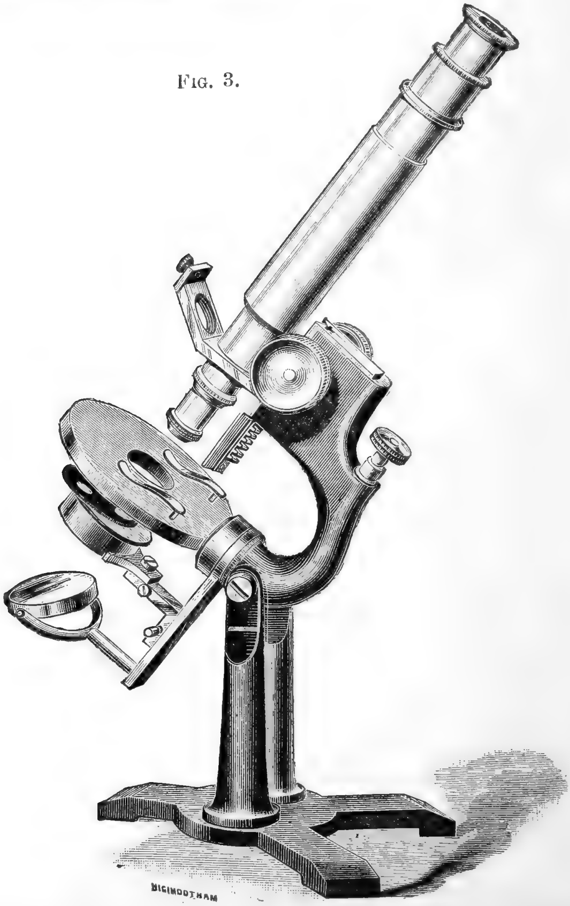


Fig. 4.

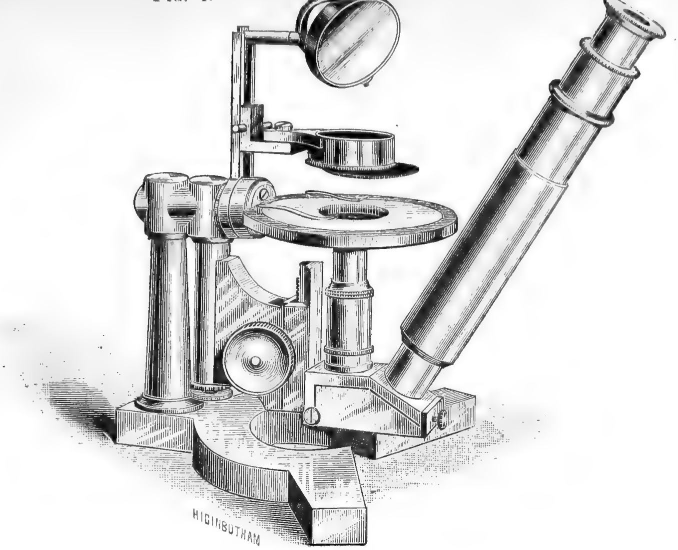
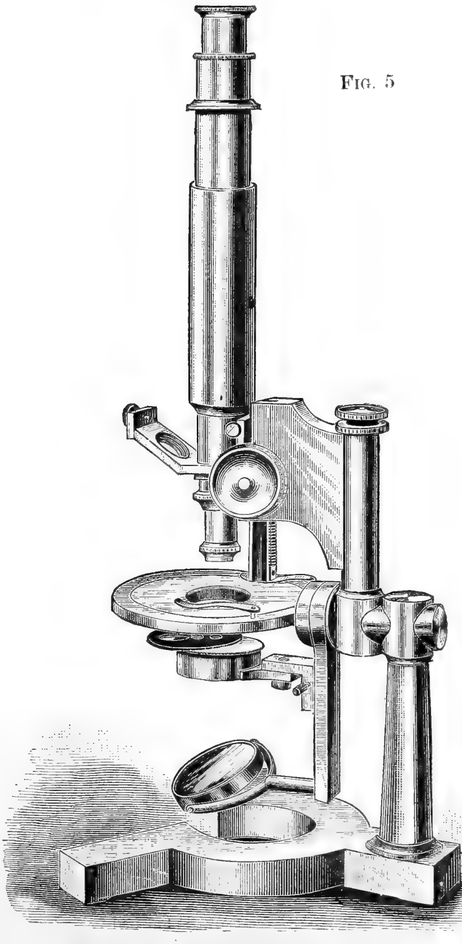


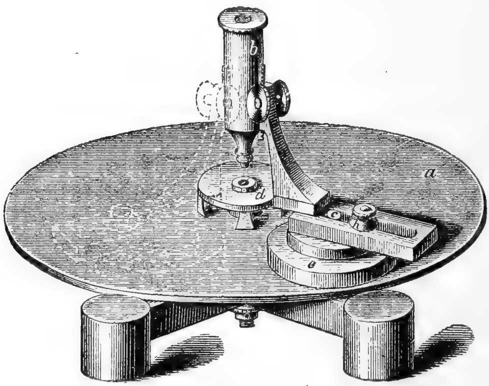
Fig. 5



in 1851, having four faces, with angles of 57°, 150°, 48°, and 105°, the rays being twice totally reflected.

Berger's Microscope for fixing Spider's Threads.*—Mr. C. L. Berger describes the following Microscope for the adjustment of distance-threads in telescopes for theodolites, &c. To fix the threads in the grooves is used a small apparatus *b* (fig. 6), which stands upon a rotating plate *a*; *b* can be both rotated about the pin *c*, and moved backwards and forwards, and

Fig. 6.



clamped by the screw *h*. The apparatus can also be moved with the stand *e* to different parts of the plate, so that the diaphragm (for the telescope) need not be moved. The latter is held by a spring on the little stage *d* in the centre of the table *a*, and there is a mirror under *d*. With this apparatus he has been able to adjust the distance-threads for use with normal levelling staffs to within 0·001 of their true position, which corresponds to an error of 0·1 foot at a distance of 100 feet. This error, especially with long distances, lies within the limits of the accuracy which can be attained with distance-threads in general, and may in most cases be neglected. By using a micrometer-screw with the Microscope, as is done with dividing machines, the threads may be still more accurately adjusted before they are fixed to the diaphragm, and the error still further reduced.

Koch's Microscope for determining Coefficients of Elasticity.†—The apparatus originally devised by Dr. K. R. Koch for his experiments on the elasticity of crystals, is now made in an improved form by Breithaupt and Son, of Kassel, and is shown one-fourth natural size in fig. 7.

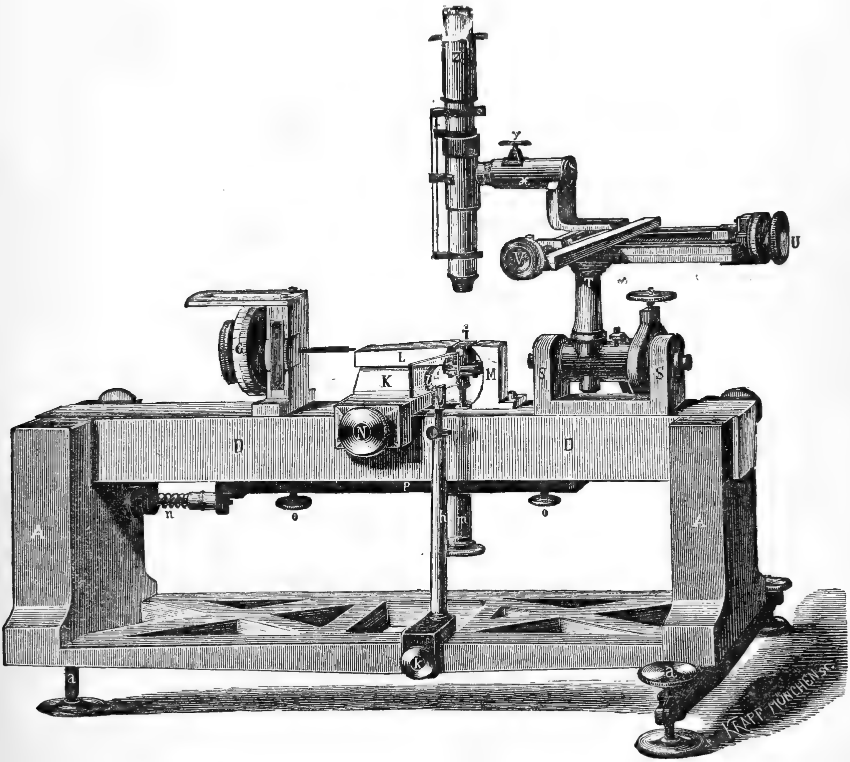
A solid stand A, of lacquered iron, supported on three levelling screws *a*, carries the steel bar D on which is fixed the steel anvil M; the upper surfaces of M and of a similar anvil L are slightly bevelled upwards, so that the plate or bar to be examined, when placed upon M and L, rests upon their inner edges alone as two linear supports; L is, however, not fixed, but is suspended on a knife-edge forming part of K, parallel to the length

* Zeitschr. f. Instrumentenk., vi. (1886) p. 276 (1 fig.).

† Groth, P., 'Physikalische Krystallographie,' 2nd ed., 1885, pp. 660–6, 3 figs.

of D, so that when the plate is in position, and loaded with a weight, L adjusts itself to parallelism with M, and the plate rests evenly upon the two edges. The block K which carries L is not fixed, but is made to slide along the bar D, and is clamped by the screw N; in this way the distance between the inner edges of L and M can be set to any length between 10 and 30 mm. Between L and M and beneath them is a totally reflecting prism *i*, by which the light reflected into it by the glass plate on the rod *h* passes vertically upwards through the upper horizontal face. The prism is fixed on three screws, by which its upper surface may be adjusted to

FIG. 7.



parallelism with the plate, and it is slowly raised or lowered by a milled head at the lower end of *m*. The prism is supported on the plate *p*, and can always be brought into the middle of the space between L and M by the screw *n*, and fixed by the clamps *o o*. The position of L, and consequently the distance between L M, may be measured either by the micrometer-screw and index at G, or more conveniently by the Microscope *z*. S is a horseshoe support, in which turns an axle bearing the pillar T and clamped by *s*. Upon T are the two slides with micrometer-screws U V, by which the Microscope *z* can be moved horizontally through measured distances, either parallel or perpendicular to the length of the bench; *z* turns about the axle *x*, which is clamped by the screw *y*. The Microscope itself

is of small magnifying power, and is roughly focused by raising or depressing the tube, while by turning a grooved ring in the middle of the tube a fine-adjustment is obtained; there is a fixed and a movable thread with graduated circle.

In using the instrument, the Microscope, fixed in the vertical position by a stop on the axle S S which abuts on D, is first adjusted to the inner edges of L and M successively by means of the micrometer-screw V; (U and V have drums divided into 100 parts each, equivalent to a motion of 0·005 mm.); this determines the distance between the edges and the position of the experimental plate upon them. The screw *s* is then loosened and the Microscope is rotated about the axle S S into the horizontal position, where it is held by a second stop and counterbalanced by a weight fixed on the lower end of T. It is then focused upon the upper surface of the prism which is slightly curved; the prism is raised until it just touches the plate with its central point, and the interference rings are seen in the field of view, when monochromatic light is reflected into the prism. If a small space intervenes between the plate and the prism, then when the plate is loaded this space is diminished and the interference rings travel across the microscopic field, a motion through the breadth of one ring being equivalent to a vertical displacement of half a wave-length; in this way the extent to which the plate is bent may be measured in fractions of a wave-length.

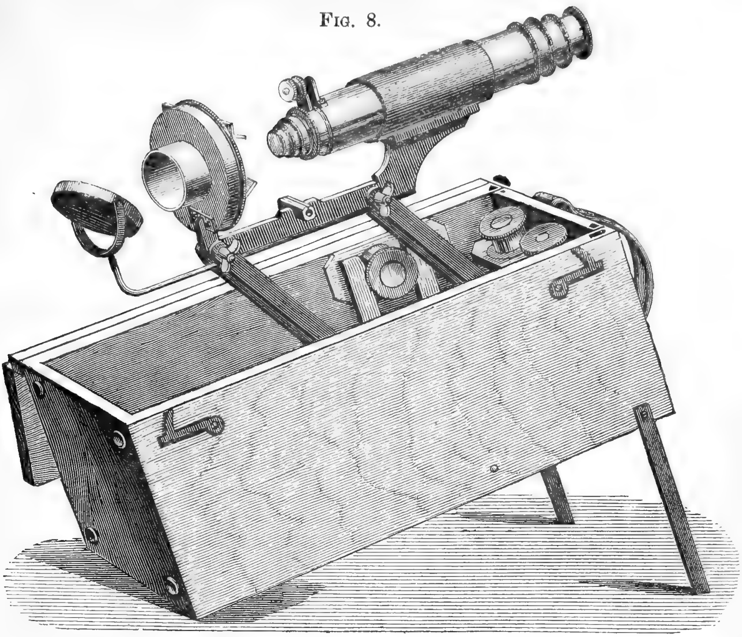
The apparatus above described constitutes a complete micrometer for the measurement of lengths and angles within the space of 4 sq. cm. covered by the motions of the screws U and V, and may therefore be applied to microscopical measurements for a variety of purposes. In this case the object to be measured is placed upon an object stage, which rests upon D above K and M, and is provided with a rotating glass plate mounted in brass, and illuminated either with a lens from above, or from below with the prism or a small mirror. In this form the instrument is especially applicable to the measurement of Senarmont's or Röntgen's ellipse of heat-conductibility, and to the examination of etched figures upon crystal faces; for the latter purpose it is particularly convenient when it is required to measure the angle between the edge of an etched figure and an edge of the crystal which is at some distance from the same, that is to say, when the crystal is so large that a well-defined etched figure and the outline of the crystal face are not visible together in the Microscope; in such a case the movable thread is adjusted to the edge of the etched figure; the Microscope is then shifted by means of the screws U V until the edge of the crystal appears, when its direction may be determined by the movable thread.

Moginie's Travelling Microscope.—This (fig. 8) was designed by the late Mr. W. Moginie, in order to provide an instrument which could be very rapidly set up when travelling, and without the necessity of separating it from its case.

The limb supporting the socket for the body-tube and the stage is attached by thumbscrews to the upper ends of two pairs of parallel bars, the lower ends of which turn on pivots fixed to the bottom of the box. When the bars are depressed the limb, with the body-tube, stage, and mirror, drops into the box. The loss of time in the operation of taking a Microscope out of its box and replacing it again is thus avoided.

At one end of the box are two flat rods or feet, turning on pivots and allowing the box to be inclined, as shown in the fig. On the bottom are two similar feet which also turn on pivots, so as to extend horizontally on

FIG. 8.



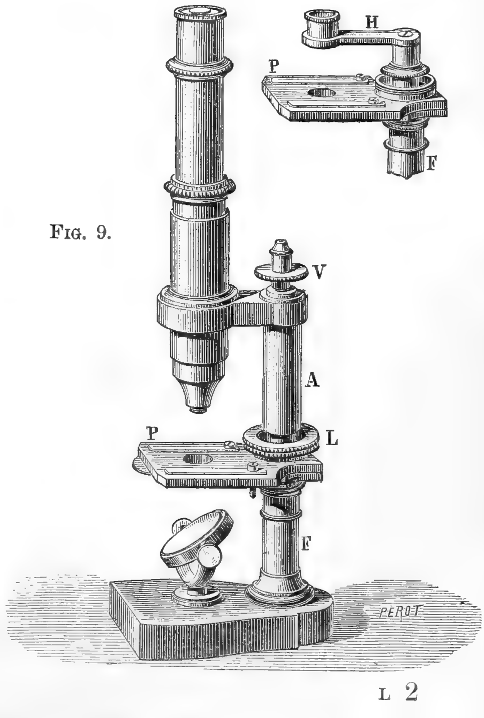
either side of the end of the box, increasing its stability when the Microscope is used in a horizontal position.

The box contains eye-pieces, cameras, animalcule-boxes, and other accessories.

Nachet's Compound and Single Dissecting Microscope.—In this instrument (fig. 9) M. Nachet has applied the arrangement of his Travelling Microscope for readily converting it from a compound to a single Microscope. This is accomplished by unscrewing the milled ring L at the base of the pillar V A, when the latter, with the body-tube, can be removed from the lower part of the instrument P F, and an arm H, carrying dissecting lenses, substituted.

Though the conversion is rapidly effected, the connection does not appear to be in any way wanting in solidity.*

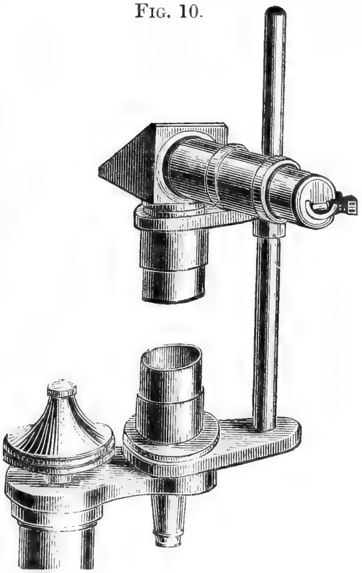
FIG. 9.



* A similar arrangement was adopted in the Nachet Travelling Microscope.

Pfeifer's Embryograph.*—This piece of apparatus, the work of Mr. A. Pfeifer, the instrument-maker of the Biological Laboratory of the Johns-Hopkins University, Baltimore, "renders the Zeiss-Oberhauser camera available for drawing objects under very low magnifying powers." It consists, first, of a collar fitted to the arm of the Microscope, and furnished with a short draw-tube, which can be placed with the objective either above or below the arm; and, second, of a vertical rod, supported on an arm which is clamped under the collar of the draw-tube, and carries a second movable arm resting in a collar to support the camera. This arm is held in place by a thumb-screw, and it may be set at any point on the vertical rod. When the Zeiss *aa* objective is used, and the camera is lowered as much as possible, an image magnified about three diameters is projected on the paper, and any amplification greater than three diameters may be obtained by varying the height of the camera, and by the use of the higher objectives.

Fig. 10.



Schott's Microscopes.—A matter that has long puzzled microscopists has happily found a solution, and although the discovery is not calculated to produce any revolution in microscopy, it is worthy of being recorded in a microscopical journal.

Gaspar Schott, in his 'Magia Universalis,'† figures and describes among others the Microscopes shown in figs. 11, 12, and 13. These Microscopes, as will be seen, are apparently of an exceptional and extraordinary size, and no explanation is furnished by the text or otherwise of the advantages supposed to be obtained by their large dimensions. So far as anything is known of the ideas of Schott's contemporaries, there is nothing that in any way tends to show that the uselessness of mere size was not thoroughly appreciated, so far as Microscopes at any rate, in contradistinction to telescopes, are concerned. Added to this, Schott himself writes of gold and silver dust, small seeds, &c., being viewed by these Microscopes, objects which are obviously unsuited for large instruments. As no reasonable explanation was forthcoming, some microscopists fell back upon the notion that Schott was drawing upon his imagination for the whole thing, and that no such Microscopes had ever in fact been made.

We recently received from Prof. Abbe, Traber's 'Nervus Opticus,'‡ and we happened to open it at the plate containing the three drawings

* Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 480–1 (1 fig.).

† G. Schott, 'Magia Universalis naturæ et artis. I. Magia Optica.' 4to, Herbipolis, 1657, pp. 533–6, pl. xxv. figs. 5, 7, and 8.

‡ P. Traber, 'Nervus Opticus sive Tractatus Theoricus, in tres libros Opticam, Catoptricam Dioptricam distributus,' xxii. and 226 pp. and 35 pls., fol., Viennæ Austriæ, 1690.

which are reproduced in figs. 14, 15, and 16.* It seems to us that these drawings at once furnish an explanation of the difficulty. It will be seen

Fig. 11.

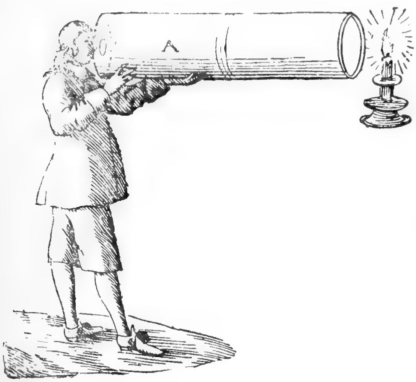


Fig. 12.

Fig. 13.

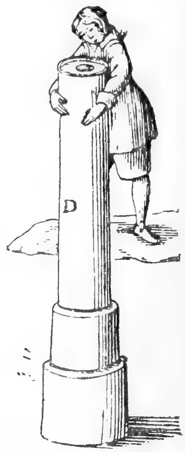


Fig. 14.

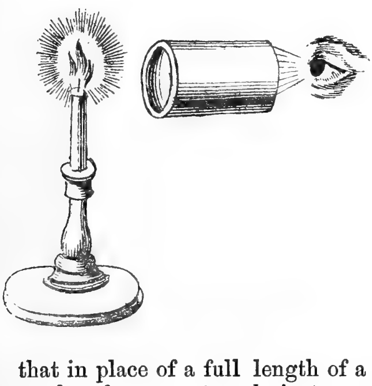


Fig. 15.

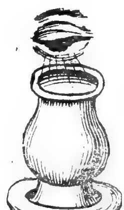
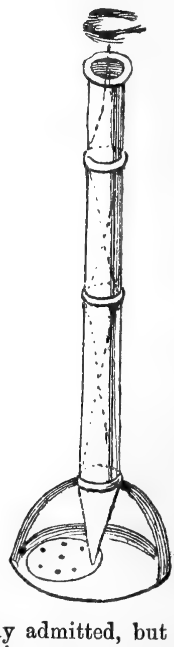


Fig. 16.



that in place of a full length of a man being drawn as the observer at each instrument, *an eye* only is given. The change that this makes requires no enforcing. The whole scale is at once altered, and the Microscopes are reduced from their apparent size of 4 or 5 feet to scarcely as many inches. Schott's draughtsman was probably of an artistic turn of mind, and added the full-length figures with the view of enlivening and illuminating what he probably felt to be very inartistic pictures. That he succeeded in making much prettier pictures may be freely admitted, but he little thought to what erroneeus deductions his artistic tastes would give rise.

We are not overlooking the fact that Traber's book was not published

* Tom. cit., pp. 66–8, Lib. i. Tab. iv.

until 1690, while Schott wrote in 1657, but this cannot militate against the striking evidence furnished by the three figures. Traber, who lived at Vienna, may well have heard from Schott or otherwise of the mistake that had been made in the drawings, and corrected it accordingly.

Schiefferdecker's Fine-Adjustment Screw.*—Dr. P. Schiefferdecker describes a micrometer-screw made by Winkel of Göttingen, which is so constructed, that lateral movement is altogether prevented, and the action of the screw is very regular and easy.

Fig. 17 shows a section of the apparatus viewed from behind. The casing which carries the tube is fixed by means of an arm to a hollow trilateral

Fig. 17.

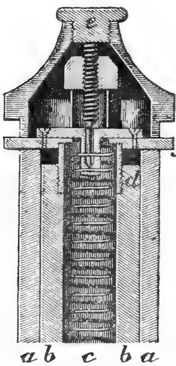
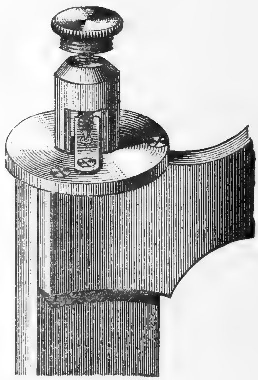


Fig. 18.



"prism" *a*. The sides, i. e. the right and left surfaces of the latter, are with the arm made of one piece; the base, i. e. the hinder surface, is screwed on to the adjacent sides. In *a* is a second trilateral prism *b*, the lower end of which is screwed to the foot of the Microscope. This prism is fitted most accurately into the cavity of the former, so that a relatively large friction resistance exists when the two prisms work against each other. The prism *b* has a cylindrical cavity *c*, beginning at the top and going down a definite distance. Its axis coincides with that of the prisms. It contains a strong spiral spring, the diameter of which coincides with that of the cavity. To the upper end of *c* is screwed a hollow steel tube *d*, the internal diameter of which is equal to that of *c*. It projects above *b*, and enters the circular opening of the brass plate *f*, which lies above *a* and closes it. The steel tube *d* is not uniform throughout its extent. After that portion, about 6 mm., which is immediately above *b*, there follows a part of 11 mm. in length, from which the right and left fourths of its wall have been cut away. On this follows a solid end-piece perforated by the micrometer-screw *e*. Through the openings in *d* passes a small brass plate or bridge *g*, which is fixed at each end to the plate *f* by a screw.

If fig. 17 be compared with fig. 18, the position of this bridge will be understood. The spiral spring presses strongly against the bridge which is firmly united to the plate *f*; this, again, is firmly fixed to *a*, which carries the tube. The spiral spring therefore exerts its pressure on the upper end of *a*, pushes on this and the tube, and presses the bridge firmly against the upper solid part of *d*. The micrometer-screw opposes the tension of the spiral spring. It presses on the bridge, not however directly, but by means

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 1–5 (2 figs.).

of a special arrangement. In the middle of the bridge is screwed a short steel cylinder, which extends into the central hollow of the spring for about 8 mm. It possesses a cylindrical cavity, the longitudinal axis of which coincides with that of the cylinder, and which ends conically. Within the cavity is placed a small steel rod, the diameter of which is somewhat smaller, so that the space is not quite filled. This rests with its lower conical extremity in the conical end just alluded to. To the upper squared off end of the rod, which is flush with the upper surface of the bridge, is fixed a small cap in which the point of the micrometer-screw is adjusted. The cap (fig. 17) is intended to protect the parts inclosed from dust, and also to give a firmer hold to the finger.

The following is the action of this contrivance. The cylinder which extends from beneath the bridge to the central cavity gives a firm hold to the spring. The rod in the steel cylinder forms the direct continuation of the micrometer-screw with the advantage of a movable point, and as the rod is of less diameter than the cavity in which it lies, the screw at its lower end is practically movable on all sides. The arrangement offers the following advantage:—If the point of a micrometer-screw is not quite accurately placed, either in consequence of imperfect work, or from warping in hardening, the screw will exert not only a vertical but also a lateral pressure. This will in turn produce a lateral displacement of the tube. If, however, the screw works on an easily movable point which is firmly united to it, and has only a slight lateral movement, vertical motion only will be communicated. Another advantage is, that the friction of the micrometer-screw is as small as possible, and therefore a very strong spring can be inserted without the screw losing its easy regular action. In consequence also of the power of the spring, the prisms *a* and *b* can be fitted so close as to create a relatively strong degree of friction.

(2) Eye-pieces and Objectives.

Finding the general character of the Components of a Cemented Combination Lens.*—Mr. E. M. Nelson premising that it is very useful to know whether a combination consists of two or three lenses, and if those are biconvex, plano-convex, meniscus, &c., gives directions for obtaining such information without uncementing. The method employed is simply the consideration of the reflected images from the surfaces of the glass.

"Take the plane mirror of your Microscope in your hand, and examine the reflection of a window. Notice that it is an erect image, and that when you move the mirror in a certain way the image appears to come towards you. Now look at the concave side, the image is inverted, and when the mirror is moved in the same direction as before the image goes away from you. A convex mirror behaves as a plane mirror, there being only this difference—that the greater the convexity the smaller is the image, which difference is also true of a concave mirror—viz. the greater the concavity the smaller the image. If you now examine a single biconvex lens, you will see a large erect image from the surface next the window, and a small inverted image from the surface on the other side. It acts precisely as if it were a convex and a concave mirror. In a single biconcave lens you have a large inverted and a small erect image. In a plano-convex, with the convex side towards the window, you will find a small erect image from the convex side, and a large inverted image from the plane side. With the plane side towards the window, you will have a large erect image from the plane side, and a small inverted one from the other side. With

* Engl. Mech., xliv. (1886) pp. 320–1 (3 figs.). Journ. Quek. Micr. Club. iii. (1887) pp. 13–7.

the concave side of a plano-concave towards the window, the concave side will give an inverted image, and the plane side an erect image; but with the plane side to the window, you will get two erect images. Converging and diverging menisci have for their convex sides two erect images, and for their concave sides two inverted. I find, however, that in a converging meniscus, if the concave surface is of very large radius, the reflection from it when viewed from the convex side will be inverted instead of erect; in other words, it will take the form of a plano-convex. I imagine that in a diverging meniscus, which closely approximates the form of a plano-concave, the same result would be found—viz. that the image from the flat side, when seen through the more concave side, would be erect instead of inverted, as one would expect; but of this I have no practical experience, not having a single lens of that form to experiment on.

"Now, if we take a cemented doublet, consisting of a biconvex and a plano-concave, we shall very easily see the two bright reflections from the two exterior surfaces—viz. the plane and the convex. The image from the cemented surfaces, however, will not be so readily apparent. With a little attention it will be discovered as a faint image, with most probably a bluish tinge, though occasionally it may have a reddish tinge. When once seen, it will be easily recognized again. A triple combination will have two faint images as well as two bright ones. I find the following the best method of procedure. First find out by the number of faint reflections if the lens is a doublet or a triplet. Next find out the nature of the external surfaces, and write them down—e. g. plano-convex doublet. This means that the combination is composed of two lenses, and that one of the external surfaces is convex and the other plane. Now write down the reflections as they come, beginning at the side next the window, underlining the reflection from the first surface, and putting the reflection from the cemented surface in (). In writing these down, I use the following abbreviations: *e* for erect, *i* for inverted, *s* for small, *l* for large, and L for very large. It is a good plan to draw the lens by representing, first, the external surfaces only, and then filling in the cemented surfaces, according to the reflections you obtain. It is absolutely necessary that the reflections from both sides of the combinations should be ascertained, as it is impossible to discover the construction of the combination from one set of reflections. When the images are large it is as well to look at the reflection of the bar across a window; the knob of the hasp showing if the image is erect or inverted. The images from small lenses require to be examined by a magnifying glass. One word of caution, and that is, until one is practised in picking up these faint images, the very large faint ones are apt to be overlooked. Until one is familiar with the manner of holding a lens, only a faint blue tinge will be seen over the glass; but after a little practice, a distinct image of the window bar will be obtained."

Some examples with figs. are given.

(3) Illuminating Apparatus.

Ahrens's Polarizing Prism.*—Dr. H. Schröder suggests that this prism† may be improved by using linseed oil for cementing instead of Canada balsam, since the surfaces may then be cut at a more convenient angle. This cement is not very tenacious, so that during the cutting and polishing of the prism the parts must be provisionally fastened with Canada balsam, which is finally removed and replaced by the linseed oil varnish.

* Zeitschr. f. Instrumentenk., vi. (1886) pp. 310–1 (1 fig.).
† See this Journal, 1886, p. 397.

(4) Other Accessories.

Super-stage for the Selection and Arrangement of Diatoms.*—Herr E. Debes's instrument (figs. 19, 20, and 21) for selecting and arranging diatoms consists of a ring A fixed to the stage of a large Zeiss dissecting

Fig. 19.

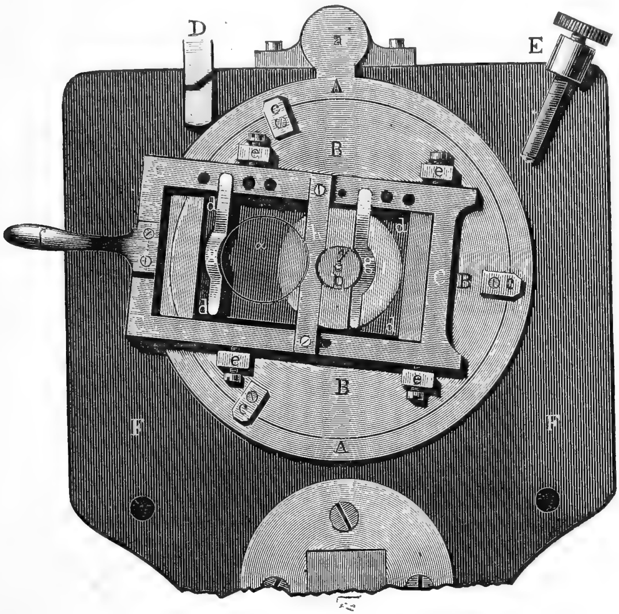


Fig. 20.

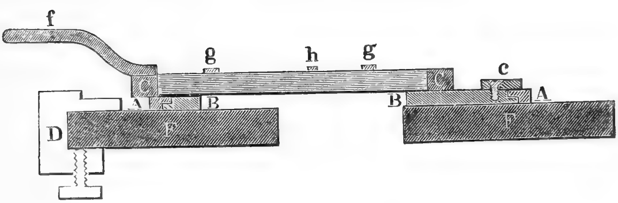
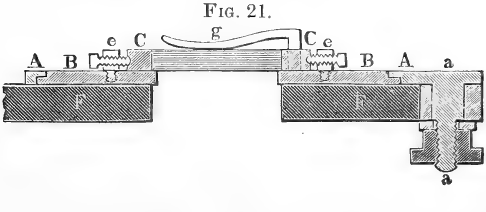


Fig. 21.



Microscope and moving pendulum-wise on the axis *a*. Within the ring is a disc B moving round the middle point *b*; the disc is provided with

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 330–6 (3 figs.).

three small bearing-plates *c c c*. The circle-segment which the middle point *b* describes when the apparatus is moved must accurately intersect the middle of the field of view. The movement of the ring A is limited on the left side by the clamp D, which is movable, and can be fixed in any desired position by a screw. On the right the motion is confined by the adjusting-screw E attached to the stage F. The disc B, perforated by the quadrangular opening *d d d d*, carries the frame C which is fixed to B by the binding-screws *e e e e*. To the left of the frame is the handle *f*, having a slight tilt upwards. In the long sides of the frame C are grooves in which the screws *e* work; if the latter are drawn out, the frame can be moved in the direction of its length. The frame C carries a glass plate, two springs *g g*, and a narrow plate *h*; these last three lie upon the glass so as to leave spaces for the insertion of cover-glasses α and γ of 10 and 6 mm. diameter, the former carrying the specimens from which are selected those to be arranged on the latter.

It follows, therefore, from the construction of the apparatus, that if the centre of the cover-glass γ coincide with the central point *b*, the central point of the field of vision will revolve round its own axis when B is turned, provided that the clamp D is so adjusted that the outer frame A touches it. Similarly, when the frame is properly adjusted to E, the centre of α will remain in the field of view.

The chief advantage of this instrument consists in its automatic precision, the hair used for arranging being always within the field of view and under the control of the preparer.

Hildebrand's Slide-carrier.*—In Dr. H. E. Hildebrand's contrivance (figs. 22–24) the stage is fitted with a circular frame R, in which is inclosed

Fig. 22.

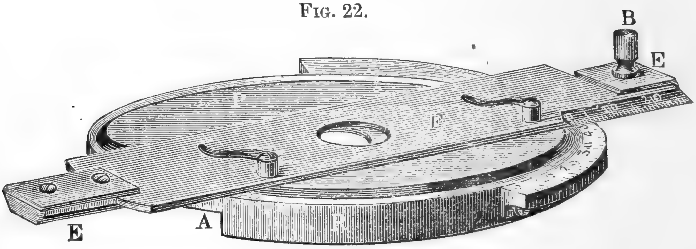
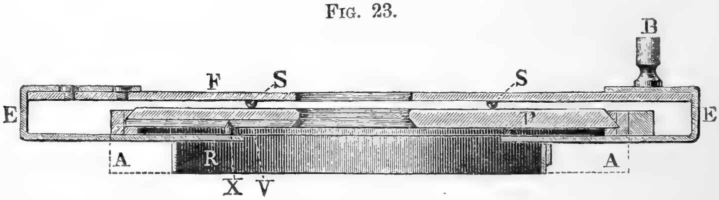


Fig. 23.

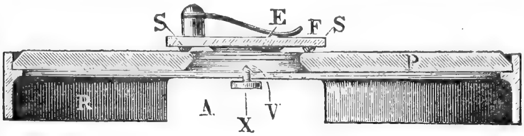


a glass plate P with a central aperture. The slide-carrier proper is a metal plate F, with a circular opening in the middle. This plate moves over

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 386–9 (3 figs.).

the glass on four pegs S, and is kept in position by the square springs E, for the passage of which two sections A of the frame R are removed. Running from the left section A directly inwards as far as the central aperture is a groove V, 1 mm. deep, on the under surface of the glass plate P. In this groove works a short guide-pin X, connected with the end of the left rectangular spring E. When pressure is made on the handle B

Fig. 24.



the carrier is moved to and fro along the groove, or in arcs of which X forms the centre, or in a combination of the two movements. As the figs. show, a finder can be employed.

The apparatus admits of some modifications, such as having the upper surface of the glass plate grooved instead of the lower.

(7) Miscellaneous Matters.

The New Glass.*—In an article widely copied by the American daily press from the 'St. Louis Dispatch' occur some rather startling statements concerning the discoveries of "Prof. Abbey" and "Dr. Scott," of which the following is a very brief extract.

"That a recent wonderful discovery in microscopy has not been even noted in the public press may be cited as proof of the general apathetic tendency as regards scientific matters. The Microscope has always been regarded as a wonderful instrument, but by the discovery of an entire new kind of glass lately, its powers are increased to an incredible degree. . . . With the old glass the full power of the Microscope was the discernment of the one-five-hundred thousandth part of an inch, and with the new glass it is claimed that the one-two-hundred-and-four-million-seven-hundred thousandth part of an inch can be distinguished. This certainly seems incredible, but positive assurance of its truth is given by parties who have tested Prof. Abbey's and Dr. Scott's new instrument."

Errors of observation in reading divided instruments.†—Herr H. F. Dorst has endeavoured to compare the relative accuracy of the three methods by which fractions of the divisions on graduated instruments are determined in making measurements; these are (1) direct estimation, (2) measurement by vernier, (3) measurement with micrometer Microscopes, and the errors corresponding to them may be called respectively estimation-, coincidence-, and adjustment-errors.

To compare these the author made a large number of observations with the naked eye upon various instruments and with sets of lines ruled upon paper, having previously determined that his eye could be regarded as one of normal accuracy and sensitiveness. The observations were made with the graduations both in horizontal and vertical positions, and the probable

* Micr. Bulletin (Queen's), iii. (1886) pp. 35-6.
† Zeitschr. f. Instrumentenk., vi. (1886) pp. 383-7.

errors were calculated by the method of least squares. The following were the results:—

Estimation error, ·015 to ·059 mm.;
Coincidence error, ·002 to ·014 mm.;
Adjustment error, ·0018 to ·034 mm.

The author concludes from his experiments that from an interval of a certain magnitude the relative error of estimation (that is the ratio of the error to the interval) increases as the latter diminishes; this increase of relative error is, however, not rapid enough to involve an increase in the absolute error of the measurement, so that using the naked eye it is possible to measure more accurately with fine than with coarse graduations.

Carlisle Microscopical Society and Dr. Dallinger.—Dr. Dallinger, P.R.M.S., in accepting an invitation to be an Honorary Vice-President of the Carlisle Microscopical Society in place of the late Dr. Carpenter, wrote to Mr. C. S. Hall, the President of the Society,—

"I have delayed writing in detail up to this time, in the earnest hope that I might find time to say something to the Society in my letter that would give direction, or stimulus, to the work it so wisely undertakes. But the pressure upon me by the claims of work, compulsory or self-imposed, is so great, that I fear if I delay until I can do, in relation to my words of direction or help, as I would, I shall do nothing. I therefore write the rather to express my deep anxiety that the members of your Society should first of all keep, individually and collectively, before them the fact, that the *raison d'être* of the modern Microscope is its scientific employment. This can only be the result of a complete mastery of the instrument in all its details. The capacity to bring out what the highest optical skill has put into a lens, is one that in this day, when objectives of the first quality are of such a high order of merit, cannot be overestimated. We may determine on a certain line of delicate investigation, say the working out in persistent continuity of the life-history of some typical form of a group of Infusorians of a relatively large size (and splendid work is waiting to be done in this direction), yet, unless the worker is master of his lenses—able, that is to say, to make them *obey* him without difficulty, yielding precisely the results he wants, and not wanting anything from them that they cannot yield; making the utmost and best use of aperture, collar, and fine-adjustment; and knowing accurately what eye-piecing any given lens will admit of. These and many other things are of the utmost importance. But they imply steady effort and practice: these, with a fair knowledge of the construction of the instrument, are the keys to success, and they can be acquired by any resolute man. But beyond this the management of light and illuminating apparatus is of the first importance. If anything, this is more difficult to fully master than the efficient employment of the lens; for the use of the lens to its utmost capacity depends upon it. But it is equally within the reach of the resolute. It is when a man is master of his Microscope, as the skilful organist is of his organ, that he will enter without hesitancy, and with certainty of result, upon such investigations as, in every department of biology, and indeed of science, invite the interest and effort of the microscopist.

Of course, what I have said applies in increasing ratio to the higher power lenses. But it has also a meaning when applied to *any* power. Relatively very few amateurs have discovered the outside power of their lenses. I can see that by the use of the new achromatic lenses, the difficulty of the use of high powers of great aperture will be lessened; but perfect

mastery of the difficulties and peculiarities of our instrument is the absolutely essential precursor to successful work of any original kind, in any direction we may choose.

I note with great pleasure that several of the provincial societies are making manipulation special, and employing demonstrations in histological methods, microscopical dissections, mounting of various kinds, &c. It would be a great gain, in my judgment, in all such societies, to have similar and progressive demonstrations on the practical use of all lenses and all apparatus employed to secure their highest efficiency, in various kinds of investigation. No doubt it may be said that small societies are not always possessed of such members as could give this desirable information. This is true: but the society exists to secure this end; and since application, with such lenses and apparatus as may be within reach of the members, is all that is required in addition to ordinary intelligence, each member may advance, and the most efficient help and stimulate the rest."

Chérubin d'Orléans' 'La Vision parfaite.'—Père Chérubin d'Orléans was the first known inventor of the Binocular Compound Microscope, which he described and figured in his work, 'La Vision parfaite,' published in Paris in 1677,* the Latin edition, 'De visione perfecta,' translated by himself, being issued at the same time. Numerous references to this work have appeared from time to time in the literature of the Microscope; but hitherto the second volume, which was published in Paris in 1681, was entirely unknown, the first volume giving no indication, either on the title-page or otherwise, of the existence of a second. In a recent visit to Antwerp we were surprised to discover a copy of the work with the two volumes bound together. This second volume † is of special interest in microscopy, from the fact that it contains a full description, with figures, of Chérubin's 'Microscope Universel,' in which is described the first application (so far as we are aware) of a rotating disc of object-lenses. There are eight different powers, applied at the nose-piece of the body-tube, a system practically identical with that adopted in England sixty or seventy years later by B. Martin. This was probably suggested to Chérubin by his rotating object-disc, which he figured (plate 31, fig. 7) and described (p. 262) in his 'Dioptrique Oculaire,' published in Paris in 1671.

Value of the Microscope in Trade.‡—"D." points out of what infinite value the Microscope is in trade; and of trades selects that of brewing, "because it will be apparent to all readers that a brewer without a Microscope is almost analogous to a peacock without a tail."

Since the remarkable revelations of M. Pasteur, the brewing trade has been completely revolutionized, and a man nowadays who does not know how to use the Microscope, and who, in fact, is not an able manipulator of that instrument, does not come within the definition of master brewer. "Science has so beautified the labours of the brewers, that they have been elevated above the level of empiric soup-makers to that of, at least, semi-professional men;" and he doubts not but that "time's effacing fingers will ere long entirely sweep away the old ignorant class of men who perhaps knew well how to wash a barrel, but had no idea of the influence of certain salts and organisms on the character of their malt extract."

After pointing out the value of the Microscope in determining,

* Chérubin d'Orléans, 'La Vision parfaite: ou le concours des deux axes de la vision en un seul point de l'objet,' xxvi. and 187 pp., frontispiece, and 16 pls. and 4 figs., fol., Paris, 1677. See this Journal, 1882, p. 253.

† 'La Vision parfaite: ou la veue distincte par le concours des deux axes en un seul point de l'objet,' tome ii., xxviii. and 239 pp., 12 pls., fol., Paris, 1681.

‡ Engl. Mech., xliv. (1886) p. 391 (3 figs.).

indirectly, the purity of the air in the fermenting rooms, &c., and the important part it plays in the analysis of water, he refers to the determination of the quality of the yeast as by far the most important use of the Microscope to the brewer. "The presence or absence of certain bacteria is of vital importance, as it is these foreign organisms that cause the unhealthy fermentations that used to perplex brewers so much; but which (thanks to such men as Pasteur, Huxley, Tyndall, Lister, Budd, and others) they are now learning to detect and remove. The germs most frequently found contaminating yeast are *Bacterium lactis*, *B. aceti*, and *B. amylobacter*, and it is these three that are familiar—too familiar—to most brewers. We now know that a healthy yeast-cell should not be larger than 1/2000 in. in diameter, and as a micrometer is an indispensable adjunct to every brewer's Microscope, the size is easily measured. We know that the absence of any vacuole in the cell denotes the plant to be too young, and not fit to induce a vigorous fermentation, and that the presence of more than three vacuoles and a shrivelled cell, at once points out the yeast to be too old. We learn from the presence of an undue amount of lactic and other ferments, when it is time a change of yeast was sought, and the 'change' having arrived, we can examine it before using, and determine the age and quality of the purchase."

The author adds that as this is intended for non-professional readers, he will not enter into any lengthy detail. "This is merely to show that, whilst the Microscope affords a most pleasing recreation to many men, and a deep life-study to others, its value to a trader is not the least of its uses. The growing taste for microscopical research amongst men is a sure sign of the intellectual age in which we live; and now that a good instrument can be purchased for such a small outlay, it behoves all men to get as deep an insight as possible into the wonders of the world around us."

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["Let a ruler lean against the shade of a lamp; place the eye so near that the image is necessarily blurred, and, moving the edge of a sheet of paper back and forth before the eye, step slowly backward till apparent motion of the object ceases; continue the backward movement until the object begins to recede slightly from the screen; the space where there was no motion is that in which alone distinct vision is possible. Of course, every effort must be made to accommodate the focus of the eye to the object during the whole experiment. It is a more difficult task than one thinks, to decide by simple judgment whether an object is distinctly seen or not, except it be much blurred. If the image is fairly distinct, most people will suppose it to be perfectly so. The test described above never fails to show whether or not the judgment is correct."]
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[Presidential Address to the American Society of Microscopists, 1886.]
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["Mr. Christian exhibited an interesting test slide (his own preparation) ingeniously mounted, with a view to discover any astigmatism of the eye. It consists partially of diatoms of the *Navicula* shape. If the eye of the observer

can see simultaneously all the lines of the objects in the field well defined and resolved, then his eye is practically without astigmatic defect. The object of this important test-slide is very obvious, as incomplete perceptions are often erroneously attributed to the inferiority of the objective used, when in fact they are the result of an astigmatic defect in the observer's eye. Results of observations among microscopists often differ because the operators of instruments are frequently not aware of the astigmatic condition of their eyes."]

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[Cf. Journal, 1886, pp. 316 and 849.]

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[1, 2, and 3, see β. 4. Paper for cleaning the lenses of objectives and oculars, *post.* 5. See β.]

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[Report of the meeting and editorial comments on the apathy of the Chautauqua people, and on the conduct of a member who at the Soirée exhibited to a mixed assemblage "living" human spermatozoa, under the description of "the germs of life."]

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" " Ditto.

[" Mr. E. H. Griffith, of Fairport, N.Y., the originator and for several years past the superintendent of the Working Session of the American Society of Microscopists, is very much chagrined at a mistake which occurred at Chautauqua, and which cost him and the Society several valuable books, slides, and instruments. Having received from California some microscopical material for distribution, he announced the fact in open session, and told all who desired specimens to come to his table and help themselves. Quite a number of persons availed themselves of the offer and helped themselves, not only to the unmounted material, but to a large number of rare and costly mounted slides belonging to the Society, and some valuable books which chanced to be on the same table. Similarly, Mr. Griffith's offer to loan any instrument on his table to workers in the session, was taken to mean that the parties could keep what they borrowed —the result being a nett loss of four new and costly Griffith's turntables. No doubt those who took the books and slides did so under a misunderstanding of

Mr. Griffith's words, and they will promptly make reparation. Those who kept the turntables can scarcely be judged so leniently. Still it is possible that they too misunderstood the offer. At any rate, prompt reparation should be made. If it is not done, the matter should be looked into by the Society, and an example made of the persons who so abuse the privileges of membership. The 'nipping' of fine slides has become entirely too frequent to be pleasant to those who have to stand the loss. The writer's cabinet has suffered a greater or less depletion from this source at every meeting that he has attended, and the 'nippers' must henceforth be on their good behaviour or exposure will most certainly follow."]

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" " **Gold-plated Diatoms.**
["From A. Y. Moore we have received another novelty, namely, preparations of the diatom *Arachnoidiscus*, plated with gold by electricity. These make very rich and elegant objects, and present some interesting features, among which may be noted the prominence with which the rays or ribs stand out. Dr. Moore states that 'by making the diatom opaque, points of structure may be determined which probably would not otherwise be seen.' Certainly, independent of any scientific value they may have, these slides constitute a very attractive novelty."]
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Journ. Quek. Micr. Club, III. (1887) pp. 22-4 (T. Curties and J. E. Ingpen)—*Micr. Bulletin* (*Queen's*), III. (1886) p. 46 (G. A. Piersol)—*Naturforscher*, XX. (1887) pp. 29-31.

OUTERBRIDGE, G. E., Jun.—**The Limit of Thinness.**
[Gold leaf on glass plates not more than the 1/400,000 mm. thick.]
Scientific Enquirer, II. (1887) pp. 9-10.

Pelletan, J.—See *Mayall, J., Jun.*

PENNETIER, G.—**De l'enseignement de l'histoire naturelle et de la micrographie commerciale.** (On the teaching of natural history and on commercial microscopy.)
[Address to the International and Industrial Congress at Bordeaux, 1886, advocating natural history being placed on the same footing as physics and chemistry in the "Cours de Marchandises" of the Higher Schools, with a laboratory for microscopical technique as applied to commerce and industry.]
Journ. de Microgr., X. (1886) pp. 486-93.

PSCHEIDL, W.—**Bestimmung der Brennweite einer Concavlinse mittelst des zuzammengesetzten Mikroskops.** (Determination of the focus of a concave lens by the compound Microscope.) *SB. K. Akad. Wiss. Wien*, XCIV. (1886) pp. 66-70.

Quimby's (B. T.) Slide-carrier.

[Two thin pieces of wood, rather larger than a slide, with a round hole piercing their centre. Narrow strips of sufficient thickness are fastened between the top and bottom pieces, dividing the interspace into three compartments, into the middle of which a square of blue glass may be inserted, while the end spaces are for the clips. In the upper surface of the carrier behind is a ridge to prevent the slide from slipping down.]

The Microscope, VI. (1886) pp. 269–70.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XV.**

[On the circular solar spectrum.] *Engl. Mech.*, XLIV. (1886) p. 337 (9 figs.).

SARGENT, T. L.—See Wells, S.

SCHRÖDER, H.—**Notiz in Bezug auf Korrektion des sekundären Spektrums.** (Note on the correction of the secondary spectrum.)

[Having examined about fifty varieties of glass used by Ross and Co., from Dollond's time, and having determined the constants of each for the seven principal lines of the spectrum, he found three varieties which are suited to secure the absolute coincidence of any three lines in the spectrum; these are dense English flint, a crown glass of high dispersion and relatively low index made exclusively for Ross and Co., and a variety of plate glass containing a high proportion of aluminates which has a mean index as great as that of the crown glass. A good achromatic compound Ross Microscope being used as eye-piece, it was found that (the objective being small) absolutely no secondary colours were to be observed either at the focus or away from it, although the calculations point to the existence of such. By the combination of both sorts of crown with light English flint coincidence of the lines D E G was attained, and a combination of both sorts of crown with dense English flint was made to ensure coincidence of the lines B D G.]

Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 205–6.

Science Directory. *Sci.-Gossip*, 1886, p. 256.

Science in 1886.

["The new optical glass which has been invented by Abbe, of Jena, is of great interest, especially among microscopists, vastly improving the observing power of the instruments with which they work."]

Times, 6th January, 1887, p. 3.

STEIN, S. T.—**Das Licht im Dienste wissenschaftlicher Forschung.** (Light as an aid to scientific research.) V. Die Photogrammetrie, Militärphotographie und Optische Projektionskunst. (Photogrammetry, military photography, and the art of optical projection.) 2nd ed., viii. and 146 pp. and 170 figs., 8vo, Halle, 1887.

Stenglein's Mikrophotogramme zum Studium der angewandten Naturwissenschaften. Lief. I. 16 pp. and 12 photomicrographs, Berlin, 1886.

Strasburger, E.—**Handbook of Practical Botany for the Botanical Laboratory and Private Student.** Edited from the German by W. Hillhouse. Revised by the author and with many additional notes by author and editor. [*Supra*, p. 120.]

xxiv. and 425 pp., 134 figs., 8vo, London, 1887.

[Also edition in Russian, xiv. and 304 pp., 114 figs., 8vo, Moscow, 1886.]

TASCHENBERG, O.—**Bibliotheca Zoologica II.** Verzeichniss der Schriften über Zoologie welche in den periodischen Werken enthalten und vom Jahre 1861–1880 selbständig erschienen sind. (Index to the zoological papers contained in periodicals and which have appeared separately from 1861–80.)

[Continuation of Carus and Engelmann's Bibliotheca Zoologica, 1846–60. Parts 1 and 2 contain a bibliography of the Microscope and microscopical technique, pp. 279–348, including A. C. Swinburne's 'Under the Microscope'!].

8vo, Leipzig, 1886.

TREAT, M.—See Wells, S.

W.—**Ausstellung wissenschaftlicher Instrumente, Apparate und Präparate.** (Exhibition of scientific instruments, apparatus, and preparations.)

[Brief description of the Exhibition at Berlin, which included Microscopes and polarization and photomicrographic apparatus.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 348–52, 388-91.

WALES, W.—**A Cover-carrier for Immersion and Dry Lenses.** [*Post.*]

Journ. N. York. Micr. Soc., II. (1886) pp. 125–6.

WELLS, S., TREAT, M., and SARGENT, T. L.—**Through a Microscope:** something of the science, together with many curious observations, indoor and out, and directions for a home-made Microscope. iii. and 126 pp., 8vo, Chicago, 1886.

WINKEL, R.—**Apparat zum Markiren mikroskopischer Objecttheile.** (Apparatus for marking parts of microscopic objects.)
Title only of German Patent, Kl. 42, No. 4365.

WOOD, R. W., Jun.—**A simple Polariscope.**
[Black glass substituted for the mirror for the polarizer. Eighteen circular cover-glasses for the analyser.]
The Microscope, VI. (1886) pp. 268–9 (1 fig.).

Zeiss's (C.) Ten Thousandth Microscope.
[He "recently placed in a box with his own hands the ten thousandth Microscope he has made."]
The Microscope, VI. (1886) p. 284.

β. Collecting, Mounting and Examining Objects, &c.*

(2) (*b*) Preparing Special Objects.

Preparing Eyes of Mammals.†—The eyes of certain mammals used by Dr. A. Dostoiewsky were hardened in Müller's fluid for periods varying from a few days to several months. Many of the eyes had previously been placed for 24–48 hours in a 2 or 3 per cent. chromic acid solution. For cutting, the anterior half of the eye was imbedded in celloidin used in three different strengths (thin, medium, and thick). In each of these solutions the preparation was left for at least 24 hours. It was afterwards immersed in a mixture of 2 parts of ordinary spirit and 1 part of water. The direction of the sections was meridional, transverse, and tangential. For staining, Böhmer's hæmatoxylin and eosin were exclusively used. The logwood solution was several months old, and very weak. This device prevented the celloidin from becoming stained.

Preparing Eyes of Birds.‡—Dr. W. B. Canfield, in his researches on the accommodation apparatus of the bird's eye, employed Semper and Fredericq's method for dry preparation, and also the celloidin process. The eyes were fixed in Müller's fluid, and then hardened in spirit. For decalcification, saturated solution of picric and chromic acid, and nitric acid 2 per cent. were used. The eyes were then imbedded in celloidin by Czermak's method, and the sections, stained with hæmatoxylin and eosin, were mounted in balsam.

Preparing Molluscan and Arthropod Eyes.§—In elucidating the structure of molluscan and arthropod eyes, Mr. W. Patten notes the satisfactory results obtained by the following methods:—When sections were not resorted to, the tissues were hardened a very little and then macerated. The use of chromic acid had to be varied in strength and temperature, &c., for different regions; it was found especially useful to shift in half an hour from a one-tenth per cent. to a one-twentieth, in 24 hours back again to one-tenth, in 24 hours to a one-fifth, where it was kept for 48–60 hours. The cornea was best treated with picro-chromic, the lens with picro-sulphuric, the layer of nerve-fibres below the septum with one-fifth per cent. chromic acid for 24 hours, the retinophoræ with chromic, the rods and retinidia with one-fifth per cent. chromic at 50° C. for half an hour. The best preparations, with all the parts in the most natural position, were

* This subdivision contains (1) Collecting Objects; (2) Preparing, (*a*) in general, (*b*) special objects; (3) Processes prior to making sections; (4) Cutting, including Imbedding and Microtomes; (5) Staining and Injecting; (6) Mounting, including slides, cells, preservative fluids, &c.; (7) Examining objects, including Testing; (8) Miscellaneous matters; (9) Bibliography.

† Arch. f. Mikr. Anat., xxviii. (1886) pp. 91–121 (2 pls.).

‡ Ibid., pp. 121–70 (3 pls.).

§ MT. Zool. Stat. Neapel, vi. (1886) pp. 733–8.

obtained by killing the eyes first with one-tenth per cent. chromic acid for half an hour, allowing them to remain in one-half per cent. for 24 hours, one-tenth per cent. for 24 hours, and finally one-fifth per cent. for 48 hours or more.

Demonstration of Bile-capillaries.*—For the demonstration of the biliary capillaries, Dr. M. Miura used the following methods:—A small piece of liver, after having been in Müller's fluid for 2–5 days, is washed with ordinary water and laid in distilled water for 3–5 hours. It is then transferred for 2–3 hours to a 15 per cent. watery grape-sugar solution. It is next placed for two or three days in a 0·1–0·2 per cent. solution of gold chloride. The gold solution is to be changed two or three times. Finally the preparation is again left for two or three days in the grape-sugar solution, but without access of air, until it assumes a dark violet or black colour. The bile-capillaries are stained a purple red.

Preparing Horse-hoofs.†—In Dr. C. Nörner's investigations, directed chiefly towards the discovery of nerve-fibres, the hard corneous layers were first removed from the hoof, and then small pieces of the softer tissues were cut out and placed in osmic acid and gold chloride. Pieces of tissue were placed in osmic acid (1:100) for 24–48 hours, they were then washed and stained in picro-carmine (*in toto*). In using the gold chloride, the fresh pieces were first rendered sufficiently transparent by soaking for one to five minutes in one-third formic acid. They were then transferred to a gold chloride solution (1:100 or 1:200) for 20 hours. After washing, the gold is reduced by putting the pieces in a weak solution of formic acid for 24 hours in the dark. They were then hardened in absolute alcohol and stained *in toto* in picrocarmine. The sections were first examined in dilute glycerin, and those showing numerous nerves were placed, after staining, in dilute picric acid, then passed through alcohol to oil of cloves, and mounted in balsam.

In preparations thus treated the nerves, stained dark violet to black, show up against the red background. The author does not speak encouragingly of either method, as he found that both were unsatisfactory.

For examining the histological structure of the hoof, pieces of the softer parts were stained *in toto* in Ranvier's picrocarmine, and were then hardened in alcohol. The sections were then placed in water slightly acidulated with picric acid and mounted in balsam or in formic acid glycerin; or the pieces were first cut and then stained.

Showing Mitosis in Brain of Tadpole.‡—Prof. A. Rauber has in his researches found the following methods most successful in displaying the nuclear division in the nervous system of frog embryos. For hardening, 1/3–1/2 per cent. chromic acid, and alcohol, or Flemming's mixture of chromic, osmic, acetic acids and water, were found most satisfactory. For staining, safranin solution or gentian-violet, or picrocarmine and hæmatoxylin, alone or successively, yielded the best results.

Method of Studying Development of Genital Organs of Pulmonata.§—In his account of the development of the generative apparatus of Stylommatophorous Pulmonata, Dr. J. Brock states that *Agriolimax agrestis* is a satisfactory species to cut into sections for the purpose of orientation when

* Virchow's Arch. f. Pathol. Anat., xcix. (1885) pp. 512–21 (1 pl.).
† Arch. f. Mikr. Anat., xxviii. (1886) pp. 171–224 (1 pl.).
‡ Ibid., xxvi. (1886) pp. 622–44 (1 pl.).
§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 338-9.

dealing with sections of unknown forms or such as are likely to disturb the disposition of parts by coiling or contraction. The young were killed in 0·1 per cent. chromic acid solution, to which a little (1 drop to a 1 per cent. solution in a watchglass) osmic acid was added; they were then treated with alcohol of increasing strength, coloured *in toto*, carefully dehydrated, and cut by Jung's microtome into sections of 1/120 mm. thick. Staining was effected with alum or borax-carmine; occasionally combinations of the two gave excellent effects. In a footnote the author remarks that the finest and most precise colorations of nuclei are got with alum-carmine, in the case of molluscs and vertebrates; with Arthropods the coloration is less intense and certain, owing to a peculiar swelling of the tissue.

Preparing Sections of Stem and Root.*—In his investigation of the origin of lateral roots in Dicotyledons, M. A. Lemaire found that sections simply hardened in alcohol were not available, owing to the contraction of the protoplasm; and the same objection applies to the use of calcium chloride; the presence of tannin is also a serious obstacle to their examination. M. Lemaire finds the following process produce good results. The section is first placed in the solution of sodium hypochloride known as *eau de Labarraque*, until the colouring matters are entirely destroyed and the nucleus and protoplasm dissolved, the cell-walls being left intact. This requires a submersion of from 15 to 20 minutes; but one to two hours produces no bad effect. The best staining material is then anilin-brown, which he uses as a solution of 3–4 per cent. in absolute alcohol. The preparations after being repeatedly washed in distilled water, are placed in drops of this fluid for some minutes, then immersed in absolute alcohol, and finally in oil of cloves until they attain the desired transparency; and finally mounted in Canada balsam. Sections prepared in this way are remarkably clear, and may be preserved for a long time. Mounting in glycerin does not answer so well. The process will apply to the study of all merismatic tissues.

Preparing the Epidermal Tissues of Pitcher Plants.†—Dr. J. M. Macfarlane states that the difficulty he experienced in getting clean and large pieces of the epidermis from the different surfaces of pitchers induced him to try various methods of preparation. Maceration in caustic potash solution of 2 per cent. strength gave admirable results. The pitchers to be macerated were placed whole in beakers containing the solution, and boiled over a Bunsen flame for from 10 minutes to 2 hours. The pitchers of *Nepenthes*, if young and fresh, had both outer and inner epidermis loosened from the green cellular and fibrovascular systems after about 15 or 20 minutes' boiling; old or dried pitchers required 30 to 60 minutes. By floating them afterwards in clean water both epidermal layers could be detached with great ease. Pitchers of *Cephalotus* were macerated after 10 to 20 minutes' treatment, but those of *Sarracenia*, *Heliamphora*, and *Darlingtonia*, except when young and tender, required boiling for about 2 hours, with subsequent maceration for 2 or 3 weeks in water.

In this way not only could long pieces be obtained for continuous microscopic examination of the surfaces, but bottled hand specimens of the entire inner epidermis of *Nepenthes* could be made, showing clearly to the naked eye the attractive, conducting, and secreting surfaces, with associated glands. Similar treatment of leaves for preparations of hairs, water and air stomata, &c., give equally good results in many cases.

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 172–4.

† Rep. 55th Meeting (1885) Brit. Assoc. Adv. Sci., 1886, p. 1088.

Preparing Lactarius to show Branched Laticiferous Vessels.*—Dr. A. Weiss finds that pieces of *Lactarius deliciosus* should not be kept too long in spirit, and that sulphuric acid shows the course of the vessels very plainly, the contents of the tubes assuming quickly a blue-black colour. The surrounding tissue being greatly affected by the reagent, the laticiferous vessels appear still more clearly, and slight pressure on the cover-glass serves to separate them for some distance. Iodine water imparts to the tubes and their contents a trace of green, which is rendered more intense by potash, and the juice appears in large dark-orange coloured drops. The colour afterwards passes into brown. Ferrocyanide of potash, sulphocyanide of potash, nitrate of silver, bleach the juice. Platinum chloride, cobalt oxide, chromic acid, and potassium bichromate have no effect; gold chloride stains the vessels blue-black, the hyphæ greenish yellow. Sulphuric acid stains the contents of the vessels yellow, yellowish green, greenish black, and finally blue-black; the contents of the hyphal filaments rose-red. Iodine solution brings out a very dark almost black colour in the vessels.

Solution of Starch in Leaves.†—M. L. Brasse describes the manner in which a diastatic ferment can be extracted from green leaves. The leaves are bruised in a mortar and covered with cold water; after twenty-four hours they are pressed, 1½ volumes of 90° alcohol added, and the juice filtered. The same quantity of alcohol is again added to the filtrate and the precipitate thrown on a filter, and rapidly washed with alcohol of 65°. The diastase is obtained in solution by dissolving the washed precipitate in water and filtering.

New Reagent for Coniferin.‡—Dr. H. Molisch describes the mode of preparation and action of a new reagent for coniferin. We have hitherto been indebted to the reaction with phenol and hydrochloric acid for the identification of coniferin in plant tissues. A section containing coniferin, one of pine-wood for instance, if moistened with this reagent, gives in direct sunlight an intense yellow-green or blue-green or sky-blue. By the aid of this the general diffusion of coniferin in lignified tissues was recognized firstly by F. Tiemann and W. Haarmann, and then by v. Höhnel and Singer; in fact, this glucoside is stated to be always present in woody tissues or in lignin. During the study of two new sugar reactions,§ the observation was made that thymol colours woody tissue a striking blue-green in the presence of concentrated hydrochloric acid.

The observation was carried out as follows:—A 20 per cent. solution of thymol in absolute alcohol was first prepared; with this a section of pine-wood was moistened, and as much hydrochloric acid added as would fill the space between the cover-glass and the glass bearing the object. In a few minutes a green colour developed, which soon turned to blue-green or blue; or, if the above had taken place in direct sunlight, the colour would be almost immediately a deep sky-blue.

The author then quotes from a paper of T. and D. Tommasi, published in 1881, which pointed out the fact that a greater intensity of colour is obtained when working the phenol-hydrochloric acid reaction, if previously some potassium chlorate be added to the acid. Taking advantage of this result, the following reaction is used by the author as being the most

* SB. K. Akad. Wiss. Wien, xci. (1885) pp. 166–202 (4 pls.).

† Ann. Agronom., xii. pp. 200–3. See Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 827.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 301–5.

§ See *infra*, p. 169.

serviceable in detecting coniferin. Water is added to a 20 per cent. solution of thymol in absolute alcohol as long as it remains clear and no thymol is precipitated. Crystals of potassium chlorate are then added in excess, and the solution is allowed to stand several hours, and filtered. Some paper which contained only a trace of coniferin was taken and moistened with this liquid, and a drop of concentrated hydrochloric acid added; in a few minutes, although in complete darkness, the moistened part became bluish green. With this reagent, sections from the stem of over a hundred woody and herbaceous plants were tried, and always with a positive result. In all the sections the lignified portions only became blue; in the first place the walls of the xylem-elements, then those of the pith and the bast-cells.

Finally, the author refers to a paper of Wiesner's, who states that he obtained a red-violet colour when phloroglucin, lignin, and hydrochloric acid are brought together. The presence of phloroglucin in some measure conceals the reaction for coniferin; but not so much so as to make it altogether inapplicable.

Engelmann's Bacterium-method.* — Dr. N. Pringsheim replies to Engelmann's further defence † of the accuracy of this method of determining the intensity of the evolution of oxygen in plants under the influence of sunlight. He reasserts the inadequacy of the method of successive observations, from the inconstancy of the minimum width of the cleft needful for the movement of the bacteria in the different colours. The movement can often be followed up to the disappearance of the object, and it usually ceases in all colours at nearly the same width of cleft, which, in direct sunlight, is about 0·008 mm.; while, on the other hand, the minimum widths for the visibility of the movement in the different colours of the spectrum—red, yellow, green, and blue—do not stand in a constant relationship to one another, as required by Engelmann's theory.

Preparing the Bacillus of Lustgarten.‡—MM. Alvarez and Tavel have modified Lustgarten's method as follows: instead of sulphuric acid they use 2 per cent. oxalic acid; a stay of two hours in the warm solution they find sufficient; and they double stain with eosin, picro-carmine, and safranin. They approve De Giacomi's method if the iron chloride be strongly acid. Against Lustgarten they maintain that the syphilis bacillus, like that of tubercle, strongly resists decolorization by acids (33 per cent. nitric, hydrochloric and sulphuric acids). The authors, however, mention a difference between the two bacilli, which is, that Lustgarten's microbe becomes immediately unstained by alcohol after treatment with acid: the acid must therefore be well washed out in water, if the colour is to be retained.

Method of obtaining Uric Acid Crystals from the Malpighian Tubes of Insects, and from the Nephridium of Pulmonate Mollusca.§—By the method adopted by Dr. C. A. MacMunn, he obtained abundance of crystals of uric acid from the contents of the Malpighian tubes of a single insect, and the method is therefore likely to be useful in determining whether a given organ in an invertebrate animal discharges a renal function or not.

The insect examined was *Periplaneta orientalis*. The Malpighian tubes, after crushing, were boiled in distilled water to dissolve the supposed

* SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 93.
† See this Journal, 1886, p. 705. ‡ Arch. de Physiol., xvii. (1885) p. 303.
§ Journ. of Physiol., vii. (1886) pp. 128–9.

urate or urates, the extract evaporated to dryness, the residue extracted with boiling absolute alcohol and this extraction twice repeated, the alcoholic solution poured away, the residue again boiled in distilled water and filtered while hot. To the filtrate an excess of acetic acid was added, and after the lapse of some hours crystals were easily found with a 1/5 in. objective. These occur mostly in hexahedral plates, also in the so-called "coffin-shaped" crystals and in prismatic needles crossing each other, also in groups of star-shaped form composed of prismatic and "whetstone" crystals, and in other forms.

Some of the residue, when evaporated to dryness and nitric acid was added, effervesced; on evaporating the acid the residue was reddish. On holding a glass rod wet with ammonia close to it, a fine purple colour was seen, and on adding caustic soda instead of ammonia it showed a beautiful violet colour.

On applying the same methods to the contents of the nephridium of *Helix aspersa* a similar result was obtained, the crystals, however differing in shape and size, but corresponding, nevertheless, to the well-known forms in which uric acid is known to crystallize. Some of the crystals obtained were cubical, some hexahedral, others prismatic with truncated angles, others coffin-shaped, and so on. Both in the case of *Periplaneta* and *Helix* the size of the crystals depends on the method of preparation; for instance, they are smaller when the acetic acid solution is boiled.

The dried residue in the case of *Helix* also gave the murexide reaction distinctly, and the above-mentioned colour changes with caustic potash.

From the nephridium of *Limax flavus* similar crystals were obtained, and in this case too the murexide reaction was equally well marked.

In the juice of the nephridium of *Helix* spherical crystals are found, which have been mistaken by some observers for crystals of the colouring matter of the so-called bile of this mollusc; they probably consist of urate of soda (and calcium), and are at all events the urate of the base which yields uric acid by the above treatment. In their interior needles can be seen radiating from the centre to the periphery. It has been shown by Griffiths that the "green gland" of the crayfish can be made to yield crystals of uric acid, and he has more recently found uric acid in the organ of Bojanus of *Anodon*, but in his experiments caustic potash was used; a method open to the objection that possibly, though not probably, the reagent may have had something to do with the result; but in the present case acetic acid was the only reagent used, which is not open to this objection.

Hence it may be safely concluded that the view held that the Malpighian tubes of insects and the nephridium of the Pulmonate Mollusca function like the kidney of vertebrates is quite correct.

(4) Cutting, including Imbedding and Microtomes.

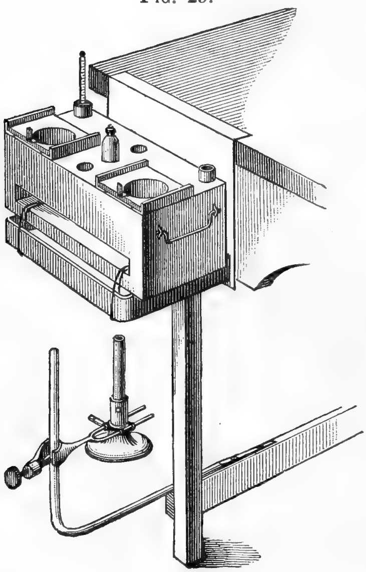
Water-bath Apparatus for Paraffin.*—Mr. E. L. Mark finds it preferable to have a water-bath for each student instead of a common tank for all, a plan which has the advantage of all the materials being close at hand. Moreover, it is more convenient to have the top of the bath nearly level with the top of the table, rather than as a tripod standing on the table. The gas-jet should be adjustable for distance in preference to the bath.

The bath (fig. 25) is a modification of that used at the Naples Zoological Station. It is fixed on a wrought-iron bracket to the end of the work-

* Amer. Natural., xx. (1886) pp. 910-4 (3 figs.).

table, so that a space of 25 to 30 mm. is left between the edge of the table and the bath. The bracket is made of band iron, 25 × 3 mm., bent into a rectangular form. The gas-burner is carried by a movable forked clamp fixed to an iron rod bent at right angles, and which is screwed to the legs of the table.

Fig. 25.



The water-bath itself is made of tin-lined burnished copper, is 18 cm. long, 9 cm. broad, and 8 cm. high, and has an oven 1 cm. high near the bottom for heating slides. The water-space communicates externally by one "chimney" only.

In the top are two large and four small copper-lined wells. One of these is 7 cm. deep, the rest 4 cm. deep. The two larger wells are 6 cm. in diameter, and each receives a copper tank provided with a handle and a nose. On either side of the larger wells copper ledges are fixed for supporting glass plates to protect from dust.

In order to fill the wells with paraffin and to support the object to be imbedded, ladles made by beating out the end of a piece of copper wire are recommended. Of the smaller wells, three are 18 mm. in diameter and are intended for 2-drachm vials. The fourth well has a diameter of 24 mm., and is intended for a mercurial gas-regulator.

Orienting large objects in paraffin.*—Mr. E. L. Mark finds that for large objects all that is necessary is to place the glass plate on which the imbedding is to be performed on the top of an ordinary glass dish (5 cm. deep and 10 cm. in diameter is a convenient size), at the bottom of which a small mirror is so adjusted as to make an angle of a little less than 45° with the horizon. With the mirror turned towards the window the outlines of the object are rendered sufficiently distinct for most purposes of orientation.

Pfeifer's Revolving Automatic Microtome.†—Mr. A. Pfeifer's microtome (fig. 26) was designed to save time and labour in the preparation of series of sections, and to attain at the same time the greatest uniformity in the thickness of the sections.

The mechanism is very simple. The frame B contains a horizontal screw beneath the sliding carriage C. The carriage carries the knife K. This carriage is moved forward by the turning of the screw. Two arms of the frame support the axis J of the revolving wheel E, to which the imbedded object is attached. The knife K is clamped in an upright position on the arms rising from the sliding carriage, so that the edge of the knife is in the same horizontal plane with the centre of the axis J. Thus, as the sliding carriage is moved by the screw, so the knife is moved to or from the revolving object. The carriage slides by means of grooves

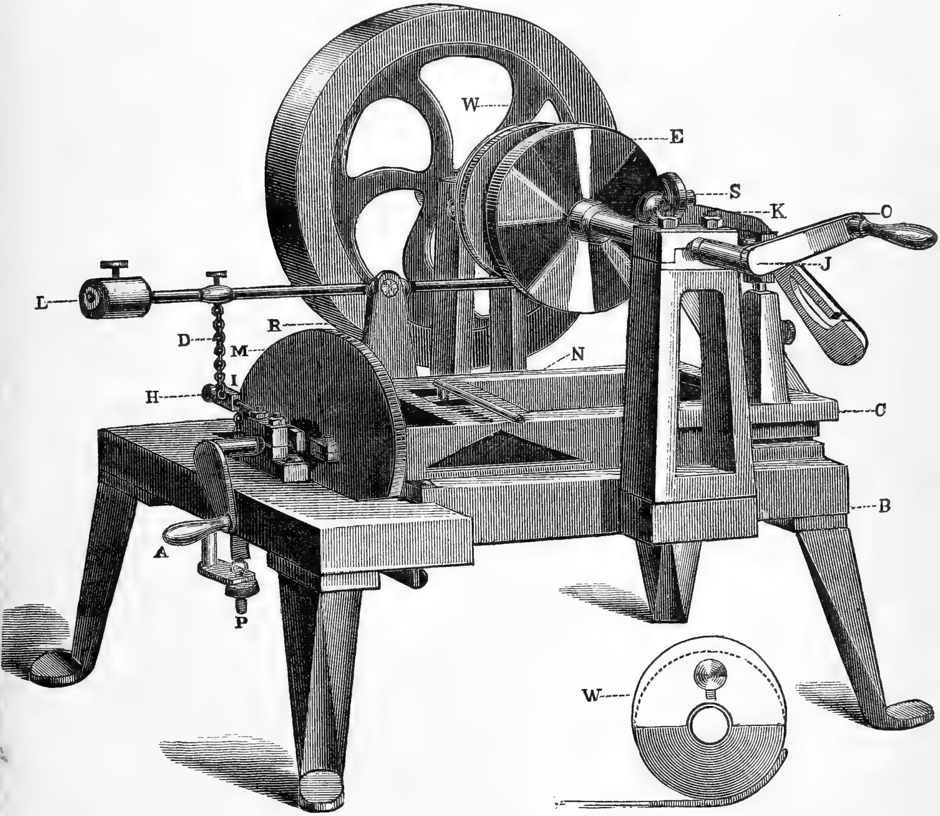
* Amer. Natural., xx. (1886) pp. 914–5.

† Studies from the Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 477–9 (1 fig.).

on raised tracks of the frame, and is not directly connected with the screw, but is simply pushed by the nut N. This arrangement makes it impossible that any slight eccentricity of the screw should cause a jolting of the carriage.

The head of the screw is a solid wheel M at the end of the frame, and has 250 ratchet-teeth on its circumference. The screw has 20 threads

Fig. 26.



to the inch. The knife, therefore, is moved an inch by 20 revolutions of the screw; and as there are 250 teeth to the revolution, each tooth represents $1/20 \times 250 = 1/5000$ inch.

The handle O turns the axis J, to which is attached the wheel E. This wheel is four inches in diameter, and to it is fastened the clamp which holds the object to be cut. The axis also carries a fly-wheel and an adjustable eccentric wheel W (figured separately). This eccentric moves a lever L, the long arm of which is connected with the small chain D. The chain lifts a small lever H, which works by means of a catch I on the teeth of the screw-head, causing the screw to revolve. The small lever is steadied and pulled back to its place by a spiral spring P, while another spring catch underneath the frame prevents the ratchet-wheel from turning back. By properly adjusting the eccentric wheel the levers may be made

to act so that the catch I will take any desired number of teeth by every revolution of the object. The knife moves only during that part of the revolution when the object is not in contact with the knife. The ribbon of sections slides downward from the knife and is caught on a piece of paper placed upon the table. The wheel holding the object, as well as the razor, can be moved so that almost all parts of the edge of the razor can be used.

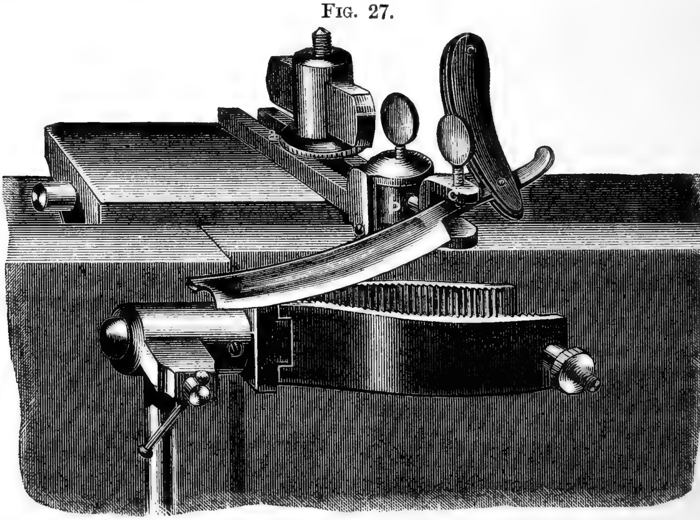
The frame-bed of the microtome is made of iron, the screw of steel, and all the rest is brass. Any ordinary microtome knife or razor may be used.

The machine has been in use at the Johns-Hopkins University at Baltimore, for a year, and gives the greatest satisfaction. It can be used with great rapidity, but so far the best results have been obtained at a rate of not over 100 sections to the minute. The only possible error in a revolving microtome of this kind is theoretical—namely, that owing to the circular motion of the object, each section is part of a hollow cylinder. But in reality, with objects of ordinary size, this error is not apparent, and even under a high magnifying power there is no perceptible difference between sections cut by this microtome and those cut by ordinary slide microtomes.

Hildebrand's Microtome.*—Dr. H. E. Hildebrand has made several improvements to his "Simple and effective Microtome" already described.† On the sides of the object- and knife-carriers excavations with roughish surfaces have been made for the reception of the thumb and first two fingers. The clamp of the knife-carrier is now made of metal and is lighter, and all the metal parts are nickeled.

Martinotti's Knife-holder for Sliding Microtomes.‡—Dr. G. Martinotti has designed a simple clamp (fig. 27) for the purpose of fixing ordinary razors to the carrier of the sliding microtome.

Fig. 27.



The arrangement consists of two clamps *a* and *c*, which are connected by a ball-and-socket joint *b*. The long bars of the clamp *a* are fixed to the

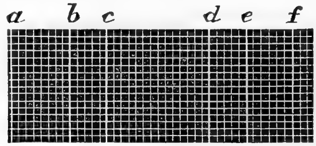
* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 392. † See this Journal, 1886, p. 886.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 390-2 (1 fig.).

carrier by a large screw. The short clamp c holds the razor (or even a microtome-knife). The ball-and-socket joint allows extensive motion in a horizontal direction, but the vertical movements, although sufficient, are more limited.

This simple accessory is intended chiefly for those microtomists who sharpen their own razors, and the only defect (which is pointed out by the inventor), is that it requires a certain amount of space between the slide and the object-carrier.

Determining the Reciprocal Positions of Object-points.*—For this purpose Prof. H. Strasser uses very thin paper ruled with fine lines as in fig. 28, and further subdivided by coarse vertical lines in such a way that the distances between $a\,b + e\,f = c\,d$ and $b\,c = d\,e$. A quadrilateral case is then formed of the paper thus ruled, by gumming the ends together so that the line f coincides with the line a. Within this case, supported by a metal box, the specimen is imbedded. Owing to the thinness of the paper no difficulty is experienced in making sections if the mass be cut with a very sharp knife. Each section is thus surrounded by a paper band in which vertical and horizontal marks are present. These marks are intended, *inter alia*, to aid in the recognition of the position of the section to the object.

FIG. 28.



Section-series and a new method for making Wax Modelling-plates.†—Prof. H. Strasser, in an article on the study of section-series, and on a means for facilitating the reconstruction of the dissociated form, describes an improvement and simplification of the plate-model system devised by Born,‡ consisting in the adoption of transparent plates which are also much thinner than any hitherto used.

The apparatus required in the preparation of the new plates are an iron roller, 4 cm. in diameter and 30 cm. in length; a water bath for keeping the wax at a temperature of 60°; some strips of tin and brass from 0·2 to 5·0 mm. thick, and a large smooth lithographic stone.

In preparing the wax plates, a piece of the still warm wax is kneaded out in the hands as flat as possible, and having been placed between two leaves of parchment paper kept moistened with turpentine, is rolled out by means of the roller previously warmed. The thickness of the lamella is regulated by the choice of the metal strips placed along the sides of the paper. When a perfectly flat layer has been thus rolled out, the parchment paper is stripped off and the plate dried between filter papers. To the surface of these wax plates paper is made to adhere by means of gum, for which purpose flour is first rubbed into the plate, or by melting it in by means of a hot roller. The plates thus produced are of fair size, and from 1/3 to 1/4 mm. thick.

In preparing wax-paper plates to which the section-sketch is attached, a very similar procedure is carried out. This method is to be preferred to the former as a rule. One of the leaves of tracing paper is placed on the lithographic stone damped with turpentine. On the other side is laid a strip of metal, then the wax is spread over the surface and the second leaf of tracing paper having been adjusted, a flat lamina is produced by rolling as before with the heated roller. The thickness of these plates, paper and

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 192–5 (1 fig.).
† Ibid., pp. 179–92 (1 fig.) ‡ See this Journal, 1884, p. 634.

all, may not exceed 0·2 mm. Although firm in consistence, they are perfectly flexible, and are cut with sharp knives or scissors quite easily.

The author mentions also a mixture of gum-tragacanth, sugar and flour, as capable of being rolled out into very thin plates, but does not indicate the proportions of the ingredients.

(5) Staining and Injecting.

Rosanilin Nitrate for Goblet and Mucous Cells.*—Dr. J. H. List now uses a 0·0001 per cent. of rosanilin nitrate for goblet and mucous cells. Sections taken from 50 per cent. alcohol are overstained in the above fluid for ten to fifteen minutes. The superfluous stain is then extracted in absolute alcohol. The nuclear structure, as well as the reticulum of the cell, are well shown. After hardening in chrom-osmium-acetic acid, the chromatin of the nucleus comes out extremely well. The karyokinetic figures in epithelium are also well shown.

Absorption of Colouring Matters by Plants.†—Dr. W. Pfeffer, as previously recorded,‡ has discovered that certain anilin colours are taken up by living cells and eventually assimilated. It is possible, therefore, that these dyes may be used to study the processes of absorption. If, for example, *Trianea bogotensis* is placed in a 0·001 to 0·002 per cent. solution of methylen-blue, the cells of the root-hairs will be found, in a few hours, to be stained a deep blue, while blue granules are discerned in the cells of the root-epidermis. The solution must not be too strong as a poisonous effect is produced on the plant. Assimilation of methylen-blue takes place when plants are left in a solution of one part methylen-blue to ten million parts of water. The pigment may be removed without damage to the plant by a 0·01 per cent. solution of citric acid.

Methyl-violet, cyanin, fuchsin, methyl-green, Bismarck brown, are taken up to some extent, nigrosin and anilin-blue not at all.

Methyl-violet and cyanin stain the cell-protoplasm without damaging the life of the cell, and the blue staining of the protoplasm by cyanin demonstrates also the alkalinity of the protoplasm.

Relation of Fatty Matter to the Receptivity of Staining in Micro-organisms.§—Dr. A. Gottstein after treating sections and cover-glass preparations with fat-dissolving reagents (heating the preparations with caustic potash in alcohol 2–5 per cent.), finds that tubercle bacilli, treated by the Ehrlich method, give the characteristic reaction, while smegma bacilli lose their acid-resisting property when manipulated in a similar manner. The author remarks that while ordinary fats lose their anilin staining after the action of an acid, lanolin, like cholesterin and certain fat-crystals (Celli's and Guarnieri's pseudo-bacilli) presents a similar resistance to acids, as do tubercle bacilli; hence smegma bacilli probably retain their staining capacity from the presence of a body analogous to lanolin.

Phloroglucin Test for Lignin.‖—Herr A. Tschirch finds the application of phloroglucin-hydrochloric acid a very useful test for the degree of lignification in wood; or, since the bark of most Angiosperms contains phloroglucin, hydrochloric acid alone may frequently be used. In this way it is shown that the bracheids are much more strongly lignified than the stereids in a "mixed ring,"¶ the former taking at once a dark-red

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 393.
† Bot. Ztg., xliv. (1886) pp. 114–25.
‡ See this Journal, 1886, p. 638.
§ Fortschr. d. Med., iv. (1886) p. 252.
‖ Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) p. 325.
¶ Cf. this Journal, 1886, p. 1008.

stain, the latter becoming only gradually red. The staining by hydrochloric acid alone was very distinct in all woods examined except those of *Sambucus*, *Juglans*, and *Colutea*, in which it was but slight. In *Syringa* the bracheids were coloured blue-green by this reagent. Instead of hydrochloric acid, concentrated sulphuric acid may also be used, when the lignified cell-walls of plants which contain phloroglucin are coloured cherry-red. The red staining begins on the cambial side of the bast-bundles, showing that the chief seat of the phloroglucin is the leptome.

(6) Mounting, including Slides, Cells, Preservative Fluids, &c.

Medland's Portable Cabinet.—Mr. J. B. Medland's cabinet (figs. 29 and 30) is 11 in. × 5 in. × $3\frac{1}{2}$ in., "only $2\frac{1}{2}$ in. larger than the ordinary case holding one-half the number" of slides. It contains sixteen trays for nine objects each. Each slide is held at its ends by the projecting side-flap of the tray, which is kept down by the succeeding tray, and so on, the lid holding the whole firmly down. When open the lid and front fall

FIG. 29.

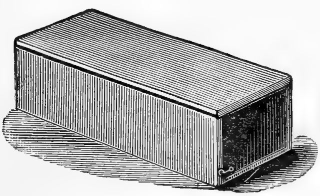
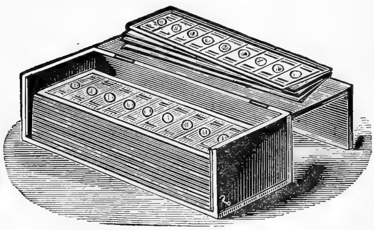


FIG. 30.



back, forming a stand or table upon which to place the trays, which are thus less liable to get displaced or upset than when placed among other apparatus or upon the work-table. The designer considers that the advantages of size, compactness, and the improvements over the ordinary case strongly recommend it to microscopists and others who may require to carry a number of objects in a small space with the least possible risk of damage.*

(8) Miscellaneous Matters.

Dissecting Pans.†—Mr. E. L. Mark recommends beeswax, rendered black with lampblack, as the best filling for dissecting pans, which should be made of glass. The most convenient size is 25 cm. by 15 cm., and about 5 cm. deep. The glass vessels are first heated in water, the temperature of which is gradually raised to near the boiling point; the hot wax is then poured in. If the surface become impaired the whole mass should be remelted, or the flame of a gas-jet be turned on to the surface for a short time.

Alling's Microscopical Records.—This book of forms is modelled after a plan suggested by Prof. S. H. Gage, modified to meet the wants of the general worker as well as the specialist by Mr. C. E. Alling.

* Cf. Engl. Mech., xliv. (1886) p. 363 (2 figs.); Sci.-Gossip, 1886, p. 258 (2 figs.); Nature, xxxv. (1886) p. 158.

† Amer. Natural., xx. (1886) p. 915.

Each page has (three times repeated) the following:—

Common Name	Method of Hardening
Scientific Name	Staining Agent
Locality obtained from	Clearing Agent
Obtained by	Mounting Medium
Mounted by	Date
Special Object of Preparation	Remarks

In addition to numbered spaces for 500 preparations, there are pages ruled for formulæ, so that they can be referred to by number and the repetition of the details with each object avoided. Also an index for cataloguing each preparation.

Gérard's 'Traité pratique de Micrographie.'*—This book, by Prof. R. Gérard, of the *École supérieure de pharmacie* at Paris, and formerly Director of the Microscopical Laboratory there, is one of the most extensive works on practical microscopy that has been published for some years. After a comparatively brief account of the Microscope and accessories, 325 pages are devoted to Botany, 48 to Zoology, and 64 to the application of the Microscope to clinical researches and hygiene. The illustrations include 279 woodcuts and 40 plates. The author gives throughout the work detailed statements of the technical processes which he has found most successful for each subject treated of.

Lee and Henneguy's 'Traité des Méthodes Techniques de l'Anatomie Microscopique.'†—Microscopists will remember the excellent 'Microtomist's Vade-Mecum' of Mr. A. B. Lee,‡ which collected and grouped in a convenient form the numerous and varied technical methods which had previously been scattered through a large number of serial publications. This work, whilst not strictly a translation of the 'Vade-Mecum,' is in the main founded upon it. Some chapters have been rewritten and extended, especially those relating to embryology, the cell, and the nervous centres. M. Henneguy claims that it includes "at once the grammar and the dictionary of microscopical technique." The translation was made by Mr. Lee and revised by M. Henneguy, and there is a commendatory preface by Prof. Ranvier.

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† Lee, A. B., and F. Henneguy, 'Traité des Méthodes techniques de l'Anatomie Microscopique, Histologie, Embryologie et Zoologie,' 8vo, Paris, 1887.

‡ See this Journal, 1885, p. 355.

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Sect. II. Animal Histology. No. 5. The Uterus. (Plate V. Uterus of Rabbit × 30.) No. 6. Mammary Glands. (Plate VI. Mammary Gland of Cat during period of lactation × 250).
Sect. III. Pathological Histology. Nos. 5 and 6. Congestion of Kidney. (Plate V. ?) (Plate VI. Parenchymatous Nephritis).
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Rocellin.
["Rocellin colours bone, connective tissue, glands, and epithelium cherry-red; gold or orange serves for fresh or alcoholic or chromic acid preparations. Bone is stained deep orange-red, cartilage, gold, connective tissue, reddish; especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels show on a gold ground; sections of skin give fine results. Preparations after washing and cleaning are best mounted in Canada balsam; oil of cloves is mostly used for clearing, but where the colours are very delicate, use oil of lavender or quite colourless oil of aniseed, as the yellow colour of the oil of cloves injures them."]
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Cf. *Micr. Bulletin* (*Queen's*), III. (1886) pp. 47–8.

THANHOFFER, L. v.—**Beitrag zur Untersuchungstechnik des Centralnervensystems.** (Contribution to the investigation-technique of the central nervous system.) [*Post.*]
Math. u. Naturwiss. Berichte aus Ungarn, III. (1886) p. 79.

Tötungsmethoden für wirbellose Tiere. (Methods of killing Invertebrata.) [*Post.*]
Tageblatt d. 59 *Versamml. Deutsch. Naturforscher u. Aerzte*, 1886, pp. 411–4.
Naturforscher, XIX. (1886) pp. 517–8.

VRIES, H. DE—**How to make colourless specimens of plants to be preserved in alcohol.**
[Cf. 1886, p. 1075.] *Nature*, XXXV. (1886) p. 149.

Water-bath for use in Imbedding. [*Post.*]
Amer. Mon. Micr. Journ., VII. (1886) pp. 203–4.

WHELPLEY, H. M.—**The Microscope in Pharmacy.** [*Post.*]
The Microscope, VI. (1886) p. 280.

WHITELEGGE, T.—**List of the Fresh-water Rhizopoda of N. S. Wales. I.**
["When gathering aquatic plants in search of any of the *unattached* forms of microscopic life, they should never be lifted entirely out of the water, but floated or pushed into a bottle with as little disturbance as possible. By adopting this method many more living forms will be obtained than would be the case if the plants were lifted altogether out of water." Also directions for preparing and mounting rotifers, infusoria, diatoms, desmids, &c., using 1 per cent. osmic acid.]
Journ. Linn. Soc. N. S. Wales, I. (1886) pp. 497–504.

PROCEEDINGS OF THE SOCIETY.

Meeting of 8th December, 1886, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 10th November last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Lee, A. B., and F. Henneguy, Traité des Méthodes Techniques de l'Anatomie Microscopique, Histologie, Embryologie and Zoologie. Avec une préface de M. Ranvier. ix. and 488 pp. (8vo, Paris (1887) 1886)	*Mr. A. B. Lee.*
Microscopical Records. (4to, Rochester, N.Y., 1886)	*Mr. C. E. Alling.*
Electric (Incandescence) Lamp for the Microscope	*Mr. R. P. Hart Durkee.*
Seven Slides and 14 Specimens of American Fresh-water Sponges	*Mr. B. W. Thomas.*

Mr. Crisp read a letter received from **Mr. Durkee**, the designer of the electric lamp which was described and figured in the December number of the Journal (p. 1053), and there stated to have been "received anonymously from America." The letter explained that a full description had been sent by the same mail as the lamp, but it had miscarried, and the letter now to hand unfortunately did not arrive in time for the explanation to be inserted in the Journal with the description.

Mr. J. Mayall, jun., said that Mr. Crisp at their last meeting had pointed out that if Microscopes were to be made for every special purpose for which they could be used, there would be a large field open, and he had to introduce to their notice that evening another of this class. It had been designed to measure with great accuracy the divisions ruled upon diffraction-plates, which was about the severest test that could be applied to any method of dividing fine lines. The Microscope upon the table had been constructed with great care by Mr. Hilger after the designs of Sir Archibald Campbell, and was capable of executing measurements over a space of nearly 6 in. The diffraction-plates with which they had hitherto been familiar only occupied a space of about 1 in.; but he believed Sir Archibald had devised a ruling-machine which would be able to rule to 6 in. Mr. Mayall then described the instrument.

Mr. Mayall also exhibited and described a new form of heliostat, also made by Mr. Hilger, for use in solar photo-micrography, consisting of a plane mirror equatorially mounted and rotated by a clockwork movement, but also having a second mirror mounted upon a universal joint attached to the polar axis, so as to admit of motion in any direction. The pencil of sunlight reflected from the first mirror could, by means of the second, be directed in any desired direction, affording to the worker the very great advantage of being able to place his Microscope and camera in any position he pleased. When properly adjusted, with the polar axis parallel to that of the earth, the clockwork would enable the reflected beam to preserve the same direction for about six hours.

Mr. F. R. Cheshire exhibited and described an improved form of inoculating-needle for use in connection with bacterium culture-tubes. It was well known that the usual plan was to have a platinum wire fused into the end of a piece of glass rod, which served as a handle; needles of this kind had the merit of being easily made, and being also inexpensive. The one he exhibited cost rather more, but possessed sundry advantages which he thought might compensate for the extra outlay. It was mounted in a wooden handle having a square ferule, which prevented it from rolling when placed upon a surface which was not level; in this was inserted a piece of very small silver tube, at the end of which was the platinum wire. On the tube a circular disc of silver was fixed, which, when placed over the flame of a lamp, rapidly became hot, and communicated the heat to the needle—silver being a very good conductor of heat. The silver tube, being very much less thick than the glass rod, could more easily be introduced without coming into contact with the sides of the glass tube; but a much greater advantage than this also arose from its comparatively small size. The diameter of the ordinary culture-tubes was generally about 1/2 in., whilst that of the glass rods was about 1/4 in. On introducing the needle, therefore, the glass rod displaced a large quantity of air from the tube, and on its withdrawal the indraught would cause a quantity of outside air to pass in, and in this way impurities might be admitted, whereas, owing to the small size of the silver tube, the displacement of air by it was extremely small. He also thought that there might be less danger to the operator in the use of the new pattern, because the needle—perhaps charged with anthrax—could not come in contact with the table at all if laid down upon it. It would also be found more convenient to use it in cases where it was desired to separate the different forms in a colony. In order to keep these needles intact, they could readily be inserted into small pieces of glass tube, and when thus placed in a case they could be carried about with great facility.

Dr. E. M. Crookshank thought this kind of needle might be found very useful in some cases, but he fancied that most bacteriologists would prefer to have the ordinary kind with the platinum wire simply fixed in the end of a glass rod by holding over a Bunsen burner. As regarded the suggestion that there might be danger from anthrax getting upon the operating-table by the use of the ordinary glass rod, he pointed out that in practice it should be made a constant habit always to sterilize a needle after use by passing it at once through the flame without putting it down.

Prof. Bell called attention to some specimens exhibited of *Tænia nana*, the smallest of the human tapeworms, originally found by Bilharz in Egypt in 1850. Though extremely rare, it had the great advantage, to the physiologist at least (though perhaps not to the patient), of being found in considerable numbers. In the present instance the worms had been found in quantities in the duodenum of a girl aged seven years, at Bellegarde. The latest specimen met with was only 15 mm. long. Prof. Bell further referred to the observations of Leuckhart on the subject.

Mr. J. D. Hardy called attention to a statement by Dr. O. Zacharias in the October number of the Journal (p. 799) with reference to the desiccation of rotifers, and in which it was stated that they could never be revived after desiccation. He thought a protest should be entered against this, as it was within his knowledge that "revivification" had taken place over

and over again. He had frequently tried the experiment, and had found that when the dried mud was moistened the rotifers constantly revived.

Mr. Crisp, having read the paragraph referred to by Mr. Hardy, and also a paragraph bearing upon the subject from the December number of the Journal, p. 989, said that, as intimated in every number, the Society did not hold themselves responsible for the views of the authors of the papers noted, the object being to present a summary of them "as actually published." With regard to the merits of the question, if a few minutes after the moistening they found the adult forms moving about, it must be obvious that they could not have come from eggs, as stated by Dr. Zacharias. In 1860 a committee was appointed by the Société de Biologie of Paris, for the purpose of investigating the question. Brown-Séquard, Balbiani, Berthelot, Dareste, and Robin were members of this committee: Broca had charge of summarizing the results and drawing up the report of the committee. This report was published in 1860, and it remains one of the most accurate statements, and the most scientifically written papers on the subject. After a long series of experiments, the conclusions obtained were that rotifers can be brought back to life after having remained ninety days in a dry vacuum, and having been submitted to an influence of a thirty minutes' sojourn in an oven heated to 100° Celsius, that is, after having been as completely desiccated as can be. These are precise and accurate facts. The committee remarked, also, that the revivification of *Anguillulæ* may be effected at least twenty-eight years after desiccation; and following Leuwenhoeck's opinion, Broca believed that during desiccation vital phenomena were much reduced, but not wholly suspended.*

Prof. Stewart pointed out that a good deal must turn on what was meant by "desiccation." It was exceedingly difficult, under ordinary circumstances, to produce a condition of complete desiccation, and it was, therefore, very probable that in all cases of revivification there was sufficient moisture retained to preserve life.

Mr. A. D. Michael agreed in Prof. Stewart's view. That rotifers did apparently revive after desiccation was perfectly clear, and if a full-grown rotifer was revived in the manner stated, it was strange how any one could be found to suppose that it had come direct from the egg. He did not see any great difficulty in freely accepting the idea that the rotifers which revived had not really been absolutely desiccated. It was quite likely that they became covered with a coating of hardened mucus, which prevented them from altogether drying up.

Prof. Bell said that this explanation had usually been accepted as the real one when this subject perennially came to the front. The most curious part of Dr. Zacharias's paper, however, was that he did not in any way attempt to criticize the observations of his predecessors on the facts, but simply declared them to be fables, not inquiring at all into the conditions under which the revivals took place, so as to ascertain whether or not they were desiccated in the same sense in which his objects were when dried up in a granite basin. Prof. Bell also read from Dr. Hudson's and Mr. Gosse's 'Rotifera' the paragraphs relating to the desiccation of rotifers (pp. 95 and 96), in the course of which the observations of Mr. Davis, recorded in a paper read before the Society in 1873, were quoted.

Mr. R. T. Lewis said he remembered that on the occasion when Mr. Davis read his paper upon the subject, he brought to the meeting by way of illustration some grapes which he had coated with gelatin, and had afterwards exposed for many hours to the dry heat of a slow oven. On being cut

* Cf. Science, viii. (1886) pp. 208–9.

open in the room the fruit was found to be in a perfectly natural condition, showing that a gelatinous coating was competent to preserve the contained moisture from evaporation.

The President said he thought the question was practically settled so far as the judgment of microscopists was concerned.

Col. O'Hara's note on the dissimilarity of appearance of crystals of blood as examined by him and the illustrations in text-books was read by Prof. Bell.

Mr. P. H. Gosse's paper "On Twenty-four New Species of Rotifera" was read by Mr. Crisp, and two plates drawn by Mr. Gosse in illustration were handed round for inspection. (*Supra*, p. 1.)

The President said that those who had seen the drawings could hardly fail to be struck with the touch of them, especially when they considered the age of Mr. Gosse. In returning their thanks to the author, he could only say that they were proud—he used the word advisedly—to have the paper.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—*Tænia nana.*

Mr. T. Bolton:—*Stephanoceros Eichhornii.*

Mr. F. R. Cheshire:—Improved inoculating needle for Bacteria cultivation.

Mr. Crisp:—Amici Reflecting Microscope.

Mr. Hilger:—(1) Sir A. Campbell's Micrometer Microscope. (2) New form of Heliostat.

Mr. B. W. Thomas:—Slides and specimens of American Fresh-water Sponges.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Edwin W. Alabone, M.D., Rev. N. Curnock, Antonio Mendoza, M.D., Albert Norris, and James Rae, M.D.

Meeting of 12th January, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 8th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Hay, W. Delisle, An Elementary Text-book of British Fungi, vi. and 238 pp., 59 pls. and 5 tables. (8vo, London, Swan, Sonnenschein, Lowry, & Co., 1887)	*The Publishers.*
Strasburger, E., Handbook of Practical Botany, for the Botanical Laboratory and Private Student. Edited from the German by W. Hillhouse, M.A., F.L.S., xxiv. and 425 pp. and 134 figs. (8vo, London, 1887)	"
Photomicrographs (11) of Diatoms	*Dr. H. van Heurck.*

Mr. J. Mayall, jun., at the request of the President, directed the attention of the meeting to eleven photomicrographs which had been sent by Dr. Van Heurck, and which the latter thought showed results of exceptional merit. The one of *Amphipleura pellucida* by transmitted light was rather striking; it showed apparently two series of lines which were resolved into dots, and, so far as he was aware, this was the best of the kind he had yet seen. But Dr. Van Heurck did not say whether it was taken from a specimen taken from a dense medium or not, nor what was the actual magnification employed. In the pamphlet which accompanied the photographs it was stated that "no diffraction lines were visible whatever," but on examination, unless he was much mistaken, they had been painted out on the negative, so that Dr. Royston-Pigott, in his remarks upon this supposed fact, had made what the French called a *boulette.* If it was desired to give such photographs a real value the background should not be interfered with, and a small tablet should be left on which should be written the particulars as to magnification, mounting, and other data which it was essential to be in possession of in order to form any reliable opinion. In the case of *P. angulatum* he thought the photograph rather failed to show the results satisfactorily. It would have been better if only a small portion of the valve had been shown including the fracture. As regarded the longitudinal lines of *Amphipleura pellucida,* he had submitted them to Prof. Abbe, who said that as they appeared closer than the diffraction lines, that was a satisfactory demonstration of their existence in the object. As to the photograph of *P. angulatum,* in which a central spot was shown, all who were familiar with the object were aware that they could get the appearance of a central spot or not, according to how they looked at it. It was a question of change of focus. *Surirella gemma* he thought was not better shown than in Dr. Woodward's photographs. Then there were photographs of Nobert's lines, which were said to be those of the 18th and 19th bands; but here again there was nothing to enable one to identify them, or to say they were not the 14th and 15th bands.

The President, in thanking Mr. Mayall for his remarks, said it must be obvious to all that it would be of immense advantage to have the data by which alone they could form anything like a correct judgment as to the value of these, or indeed any other specimens of photomicrography. He thought also that it would be of advantage if they could have the opportunity of comparing these with those of Dr. Woodward.

Mr. J. Beck said he had not looked at any of the photographs except that of *Amphipleura,* but he should say that the manipulation which it had gone through had entirely destroyed its value.

Dr. Millar called attention to a photomicrograph of *P. angulatum* taken by M. Nachet in 1867, which was fully as good as the one now shown.

The President stated that it was proposed by the Council to fill up the vacancy in their list of Honorary Fellows by electing Mr. P. H. Gosse, F.R.S.

Mr. M. Pillischer exhibited his new "Kosmos" Microscope, which was described by Mr. J. Mayall, jun., as being made on the Continental model, with a short body and a direct-acting screw, the screws being bevelled off and the corners rounded. There was a very symmetrical foot, and the finish given to the instrument made it very nice to touch. The mirror was made with a neat swinging motion, and was of a somewhat shorter

focus than those generally in use, and it was claimed that, as regarded general finish and capability, it would compare favourably in economy of price with any others.

Mr. T. Charters White read a paper on "Tartar from Teeth of the Stone Age," numerous preparations being exhibited in illustration.

Mr. Crisp exhibited a cylinder of glass made at Jena, and described by Prof. Exner in the December number of the Journal, p. 1065. Though it had plane ends it acted as a concave lens, the reason being that it was of varying density from the centre to the circumference. It solved some of the questions which had been raised as to the images formed in an insect's eye. Mr. Crisp also explained Prof. Exner's method of preparing similar cylinders from celloidin and gelatin when the effect of convex lenses was obtained.

Prof. Bell said that in the interests of the particular branch of science to which he was devoted, he might mention that a little knowledge of histology by certain observers would have shown that the cornea was quite flat in the case of the crayfish, which had nevertheless managed to see very well for a good many years.

Mr. Crisp directed the attention of the meeting to enlargements on the blackboard of the figures of enormous Microscopes in Schott's 'Magia Naturalis,' 1657. These had long puzzled microscopists, who were at a loss to understand what could be the object of making Microscopes of the large size which was indicated by the comparison with the observers represented as looking through them. Having found in an old book sent to him by Prof. Abbe—Traber's 'Nervus Opticus,' 1690—what were undoubtedly meant for drawings of the same Microscopes, the mystery was solved; for if Schott's figures of whole-length men were rubbed out and single eyes were substituted for them, as Traber did in his drawings, the scale of the Microscope represented was of course strikingly altered, and it was seen that they were small hand Microscopes after all. Schott's draughtsman probably had too much of an artistic eye. (*Supra*, p. 148.)

Mr. J. B. Medland exhibited and described his new portable cabinet for microscopic slides, in which twelve dozen slides were packed in a space 11 in. × 5 in. × $3\frac{1}{2}$ in. (*Supra*, p. 173.)

The President thought this was a very simple and practical mode of making a compact cabinet, which would commend itself at once to all who examined it.

Mr. Crisp exhibited Stein's Electric Microscope. (See this Journal, 1885, p. 303).

Mr. A. W. Bennett gave a *résumé* of his paper "On Fresh-water Algæ (including Chlorophyllaceous Protophyta) of North Cornwall," with descriptions of six new species, illustrated by coloured diagrams. (*Supra*, p. 8.)

The President said they must all feel indebted to Mr. Bennett for his very interesting communication, and they could not fail to note how very much pleasure there must have been added to a holiday in the case of one who had made himself so thoroughly master of this subject. He thought this paper was full of encouragement to others, because every young student

had the ditches and ponds open to him, and there was the opportunity for all to add to their physiological knowledge of this interesting and beautiful group.

Mr. J. Mayall, jun., gave a very interesting account of a recent visit to Jena, which he said Mr. Crisp had aptly termed the "Mecca of microscopists." There he had been afforded every facility for examining all the processes of manufacture as carried on in the factories of Dr. Zeiss. He also described his interviews with Prof. Abbe and the way in which they had together tested numerous objectives which he had taken with him for comparison. (A full description will be printed *post.*)

The President said he thought the Fellows would agree that their Society was sufficiently mature to be entitled to get the highest possible perfection obtainable with respect to its apparatus and appliances, so that whatever would contribute to the attainment of any increase in this perfection could not fail to be of the greatest interest to them. From what they had just heard, he felt sure that Mr. Mayall's visit to Jena had not been in vain; his communications would no doubt give rise to an amount of interest and attention which would be certain to bear fruit at no distant date, in the form of still further increase in the perfection of the very admirable work which they were already so familiar with.

Dr. A. C. Stokes's paper "On some new American Fresh-water Infusoria" was read by Prof. Bell. (*Supra*, p. 35.)

The List of Nominations for Council and Officers for election at the Anniversary Meeting was read by Mr. Crisp.

Mr. Hembry and **Mr. Vesey** were elected Auditors of the Treasurer's Accounts.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—Ova of Trout.

Mr. Crisp:—(1) Stein's Electric Microscope. (2) Glass cylinder with plane ends acting as a lens.

Dr. H. Van Heurck:—Eleven Photo-micrographs of Diatoms.

Mr. Medland:—Portable Slide-cabinet.

Mr. M. Pillischer:—"Kosmos" Microscope.

Mr. T. C. White:—Slides illustrating his paper on "Tartar from the Teeth of the Stone Age."

New Fellows:—The following were elected *Ordinary* Fellows:—Rev. George Bailey, Messrs. Ferdinand Coles, Sydney A. M. Copeman, M.A., M.B., Griffith Evans, M.D., F. T. Law, Reginald T. G. Nevins, and H. Virtue Tebbs.

W. H. D. del ad nat.

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Illustrating the President's Address.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1887.

TRANSACTIONS OF THE SOCIETY.

V.—*The President's Address.*

By the Rev. W. H. Dallinger, LL.D., F.R.S., F.L.S., &c.

(*Annual Meeting, 9th February*, 1887.)

Plate VI.

In proceeding to fulfil the honourable duty that by your courtesy devolves upon me, I purpose in the main to follow the line I have taken in preceding years. I congratulate the Society on its work, and on its steady influence in promoting progressive improvements in the optical and mechanical construction of the Microscope, devoid of all prejudice as to how, or from whence such improvements may come. And whilst happily it is not of necessity a President's duty to pass in cursory review the microscopical work of the year, there are times when it may be well for him to review the points of improvement that have been made in the instrument itself.

For the past twenty years I have had an increasing interest in the continuous improvement of the optical appliances of our instrument; an interest which, from the first, applied not only to objectives, but also to eye-pieces and condensers, which consecutive calculation, thought, and experience have shown to have a correlated importance.

Eighteen years ago I had by practice made myself fairly master of a 1/25 in. objective of that period, made by Powell and Lealand. I still possess that lens, and it is as good a lens of its class as they ever constructed.

Soon after I became equally familiar with a 1/50 in. of the same class by the same makers.

By saying that I became master of these lenses, I mean that I discovered exhaustively what they would and what they would not do. By this I learned definitely what I wanted in lenses if I could get it; and to get that has been my unceasing endeavour until now. And certainly the quest has not been vain. And my method has been to examine impartially, and possess myself of, English, Continental, or American lenses, whenever they have showed any capacity for doing best what my work proved to me required to be done.

I know that in estimating the quality of a lens by the class of image it affords of certain test objects well known to us, a certain amount of empiricism must take place. We do not absolutely know the image it ought to present. But this applies only within very narrow limits.

Take the Podura scale: I can give you an image of it with my 1/25 in. and 1/50 in. of twenty years ago. What I, in common with most microscopists, considered then the best result, the most sharp, clear, and delicately defined image, with those lenses, I can get now; but with those objectives, nothing better.

But the elements—the essential features that constituted the quality of beauty in that image—are the very elements, the actual features, that every admitted improvement in our object-glasses has brought out more perfectly. So that if I now put, say the Podura scale under my old dry 1/25 in. objective, and beside it another precisely similar scale under a new homogeneous 1/20 in. objective of N.A. 1·5, the very qualities of the image which I, and experienced microscopists generally, thought the best twenty years ago, are incomparably transcended in beauty and perfectness now.

But that is not, and has not been, my only or my chief test. It has been one eminently practical so far as my own work went—at least for some years.

Up to ten years ago, although I had spent weeks in patient effort, no lens that I possessed or that was within my reach could be made to reveal the flagella of *Bacterium termo*. The flagella of many minute monads, and of such bacterial forms as *Spirillum volutans*, and even *Bacterium lineola*, I could demonstrate; though some of them with difficulty, but not a trace of those of *B. termo*. But near that time Powell and Lealand produced a battery of immersion lenses on a new formula, and of much relative excellence; and with these lenses the flagella of *B. termo* were brought within the range of sight.

Since that time, that has been a good lens to me, in proportion to the greater or less ease and perfection with which it has revealed this delicate fibre. And let me say, that such lenses as do this are those that always, without fail, give us the best ideal image of Podura scales and other tests. You will pardon me, I trust, for this amount of personal reference, since it will give a greater relevancy to what will follow.

Improvements of great optical importance have been made during the last few years. The manufacture of homogeneous lenses by Messrs. Powell and Lealand, gave us the opportunity which we could not have with foreign makers, of urging certain modifications. The addition of the correction collar was a minor, but still important item. But the great point was the increase of the N.A. These makers have shown themselves most anxious, and have spared no efforts to reach the highest aperture yet attained.

Advancing, say, from N.A. 1·25 they attained to 1·38 in such powers as the 1/25 in. and the 1/50 in.; subsequently to 1·47 in a 1/8 and 1/12 in. objectives, and finding these from my working point of view of such supreme gain, I urged them still on; and was ultimately rewarded by the possession of a 1/6 in., N.A. 1·5, followed by a 1/12 and a 1/20 in. foci of the same great aperture. From each of these I obtained special advantages over all equal powers, but with lower apertures, within my reach.

A question frequently asked may be asked again, in what way these last increments of aperture aid us. The practical answer is not difficult.

Speaking from observation I may say that all the objectives I have employed for the most critical work, fail to produce images by the extreme marginal zone of the aperture. It is the judgment of competent judges that it will be fair to roughly estimate this defective outermost zone at ten per cent., so that from the total measurement of the aperture by Prof. Abbe's method, I find that in practice this amount may be deducted, as of very little service, in all apertures beyond about 1·3; hence, to be able to utilize fully any given aperture beyond 1·3, it is practically necessary that the measurement by means of Abbe's apertometer, should be about ten per cent. higher.

But a further advantage of great numerical aperture is that, other things being equal, we can utilize with excellent results deeper eye-pieces.

I have long realized the advantage, with finely corrected objectives, of a far larger series of eye-pieces than the catalogues provide. Messrs. Powell and Lealand several years ago made me one or more eye-pieces between each of their deeper eye-pieces of standard catalogued focus; and they certainly, within the limit of excellence, beyond which greater eye-piece power cannot be employed, bring out to far greater perfection the qualities of any high class object-glass.

But we have had announced to us an improvement of the optical arrangement of the Microscope, based upon an important and fundamental change in the media employed in the construction of object-glasses and eye-pieces; it will be known that I refer to the system of apochromatic object-glasses and compensating eye-pieces devised by Prof. Abbe, and under his auspices, carried out by Messrs. Zeiss of Jena.

The aim of the construction of these new objectives and eye-pieces has been to provide a higher degree of achromatism than could be reached by the old media; the new kinds of glass produced at the Jena optical glass works, under the superintendance of Dr. Schott and Prof. Abbe, can be so combined in the construction of an object-glass, as to achromatize not only the essential portion of the primary spectrum, but also to a great extent the secondary spectrum, leaving only small residuals of the tertiary order still visible under certain test conditions. The final elements of correction are supplied by "compensating" eye-pieces of special construction, designed to correct what Dr. Abbe refers to as "the differences in the amplification of the image for the various colours . . . . formed by the objective outside the axis, which cannot be corrected in the objective itself."

The first trials of these new optical combinations made in Germany evoked unstinted praise; and those who, like myself, desired nothing so much as real improvement, awaited their arrival in England with eager and even anxious curiosity.

The first that came to this country came to Mr. Frank Crisp, and by his courtesy this lens, an apochromatic of 1/8 in. focus, was placed in my hands. I subjected it to comparison, in succession, with my complete set of high powers, including those of N.A. 1·5, and upon tests, and by methods which I have indicated.

It will be well understood that the high excellence and great aperture of my three latest object-glasses, to say nothing of the very

high quality of their immediate predecessors, would have given a very elevated standard of comparison; and the result was that, after most exhaustive and critical investigation with the same tests, the potentiality of the system represented by the apochromatic lens, most powerfully and hopefully impressed me. I felt, in fact, that the lens itself was of great merit. But withal, by the standard of test the latest of my lenses enabled me to employ, I felt that its merits had been over-estimated.

It is quite true that on some of my delicate test objects, the images shown by the apochromatic lens, in combination with the "compensating" eye-pieces, appeared to advantage, when compared with my lenses combined with the ordinary eye-pieces; but when I tried my own various powers with the same compensating eye-pieces, I am constrained to say, that no real advantage over my latest lenses could be discovered. My judgment therefore was most favourable as to the immense advantage of the eye-pieces, and of the possibilities that lay in the entire system, rather than in this special apochromatic object-glass taken by itself; and although pressed again and again by the editors of journals to give a public expression of my judgment, I steadily declined, feeling that it was not, and could not at that time be exhaustive.

Later, an opportunity was courteously afforded me, by the makers, to examine a complete series of these object-glasses, from 1 in. to 1/8 in. focus, and with eye-pieces fitted for English stands.

In the examination of these objectives and their systems of eye-pieces, I spared no pains to be exhaustive and impartial. I *desired* to find the evidence of progression in optical excellence for which I am always in search, and the excellence of the 1 in. greatly impressed me; but I failed to realize my high hopes in the behaviour of the higher powers. The result, however, of a most critical examination was to very greatly strengthen my conviction of the value of the optical system which these lenses represented, and above all, of the excellence of the actually new resource provided for us by the compensating eye-pieces.

In what I have here said I must again remind you that the comparison of Zeiss's apochromatic object-glasses was with a group of object-glasses the most carefully made, most excellently corrected, and with the widest numerical apertures, of any object-glasses that had ever passed through my hands, based on the old system of correction. But with this understanding, it appears to me a responsibility that I must not evade to state the facts at this crisis in the development of object-glasses. And I do this with the more confidence, that, as I have already informed you, Mr. Mayall, wholly independently of me, examined this set of objectives and eye-pieces, and we each recorded separately in writing our judgments at the time of examination; and I subsequently found that our resulting judgments were almost identical.

During this time samples of the new optical glass had reached the English opticians, and Messrs. Powell and Lealand, in a relatively brief time, and on a formula of their own, made an apochromatic 1/12 in. object-glass and eye-pieces, constructed on the plan devised by Abbe. By the wise advice of Mr. Mayall this was exhibited at our November meeting. My high opinion of that lens and its compensating system of

eye-pieces I at that meeting expressed; and need only add that since I have become the possessor of a second object-glass of precisely similar construction and power made by this firm, I am much strengthened in the opinion I gave.

We all appreciate the splendid services rendered to Microscopy by Prof. Abbe; and it was a happy expression of that appreciation that led Mr. Mayall to propose a visit to Jena, with his Microscope and such object-glasses as he thought would worthily represent the standpoint we had now reached in England.

I understand that Prof. Abbe greatly desired this, wishing to possess the fullest information as to our methods of testing object-glasses, and to be permitted to examine our best optical work.

I need hardly say that it was a source of great pleasure to me to place at Mr. Mayall's disposal all the lenses and apparatus I possessed that would serve him: for it was in the highest interests of the microscopy of the world that so great a leader in its recent progress should see the effects of his teaching and practice as evidenced by our latest object-glasses, and especially by the new apochromatic 1/12 by Powell and Lealand, with its system of compensating eye-pieces.

Mr. Mayall has told us the story of his visit; of his kindly reception; of the earnest and repeated trials of the object-glasses he was able to submit to Prof. Abbe, and of the frank appreciation expressed by Prof. Abbe of the English object-glasses. This comparison will, in my judgment, "make history" for the future of our instrument. It will react here and in Germany. Prof. Abbe's splendid powers are more than ever concentrated on the work of touching a higher perfection in object-glasses, and he knows that every improvement initiated in Jena will be watched by keen eyes in England; and he has evidence, which will be as welcome to him as his work is to us, that we are not likely to neglect any point of excellence, provided only we can be made to see it as such.

I understand that Dr. Zeiss admits that the formulæ on which his apochromatic objectives are constructed involve far greater technical difficulties than were met with in the older formulæ; and this is evidenced by the great number of separate lenses combined in the construction.

Now it has long been my judgment, and a judgment that has been confirmed by men of large practical experience, that errors of technical execution, when present, are shown at once by deep eye-pieces: with an object of regular structure, whose image fills the field of the eye-piece, the experienced eye readily detects a want of sharpness. I am bound to say that the apochromatics from Jena did not impress me by this test as having accuracy of technical execution equal to the object-glasses with which they were compared.

On the other hand, I find that with the new apochromatic made by Powell and Lealand, I can employ advantageously, deeper eye-pieces than I had ever used before.

Now there is a less number of separate lenses in the London objective; and whether this superiority is due to the less number of lenses, or to other causes, I may not determine. I refrain from details con-

cerning the comparisons I, amongst others, made of the lower-power apochromatics of Zeiss, further than to remark that in my judgment too much has been sacrificed to the object of enabling the observer to employ very thick cover-glasses. This is, no doubt, a convenience; but if, as in Zeiss's 1/4 in. and 1/6 in., the choice lies between object-glasses that cannot be used for covered and uncovered objects, and object-glasses that, with a moderate range of thickness for cover-glass, provide that facility, the latter appear to me, from a practical point of view, to be the better.

I note with interest that Powell and Lealand have made an achromatic oil-immersion condenser of N.A. 1·4, and will probably be able to increase the aperture to 1·5 in proportion as thinner glass is used to mount objects upon. The mechanical part of this instrument had, when it first reached me, a very neat form, but was difficult of manipulating, and this involving, as it did, alteration, has prevented me from really testing its merits. But I have just received it, with a mechanical modification I suggested well carried out, and I have little doubt but I shall realize now its optical excellence.

On the whole, then, we may rejoice in the fact that a distinct advance has been made in the optics of the Microscope; and the more so from a conviction that there lies considerable potentiality still in the sources from which the amount of progress made has resulted.

At the time that I was engaged in preparing to write the Address I had the honour to give to this Society last year, I was for some time in a state of mental indecision as to which of two subjects I should take, the one I selected, or another that had occupied my attention and secured my interest for between six and seven consecutive years.

But just a short time before, an accident, which no foresight could have guarded against, happened to the apparatus employed, which occurring in my absence, brought to an abrupt termination the consecutive observations of nearly seven years.

This of course greatly depressed me; for although the observations made were in themselves, and so far as they went, most interesting, they were incomplete; for the experimental conditions I had set up, and to which I will presently refer, must have ended fatally to the organisms under experiment at some point; and that point had not been reached.

As a consequence, I, under the influence of immediate depression, came to the conclusion that I must abandon the whole matter; and I gave a brief and rough outline of what I had tried to do, to a local Society and endeavoured to forget it, choosing the subject I had the pleasure of bringing before you last year as my Annual Address.

But soon I began to look carefully over my records, and to see that what had been done was of real interest; and I found that going entirely over the ground again, with enlarged knowledge and experience, might after all be a benefit. I therefore restored, renewed, and added to my apparatus, recommenced the observations, and for several months now my thermostat has been successfully at work, repeating the observations of past years.

I have determined that a record of the former series of observations,

studied in detail, presents results that may not be without interest to this Society, even in an Annual Address.

The observations I refer to were made with a view to discovering whether it was possible by change of environment, in minute life-forms, whose life-cycle was relatively soon completed, to superinduce changes of an adaptive character, if the observations extended over a sufficiently long period.

For such observations it is manifest that the lowest forms of the infusoria offer suitable subjects.

In themselves and taken by themselves, these organisms, under such experiment must afford instruction, if we can obtain results. But it is also of interest to remember that the inference that the higher and more complex animals and plants are vast aggregations of cells differently endowed in different parts of the organism, but all functionally united and correlated to secure the life of the living thing they compose, is an admitted fact in biology. This must add, indirectly, a further interest to the subject.

Few biologists need any direct demonstration to convince them of the truth of Darwin's great law of the origin of species. It underlies as a necessity all our widest and deepest biological knowledge. Concurrent adaptation to concurrent changes of environment is in fact so apparent now, that we wonder, often, why it was not earlier seen.

Nevertheless, if it be possible to look upon the progress of changes in minute living organisms, superinduced by elected changes of environment, however simple, and which results in morphological and physiological adaptations and survivals, it cannot be other than a gain both to philosophical and practical biology.

Before actually setting up a definite line of procedure, I spent a year and a half in tentative experiment; and very soon found that the best subjects for my research would be the monad forms I had become so familiar with, and the phases of whose life-history I knew; and that the best and most amenable agent I could use for altering slowly and cumulatively the environment, was heat.

After the year and a half of trial I obtained certain very definite results, which it appeared to me pointed to the possibility of obtaining others of a far higher meaning and value, if the methods of conducting the inquiry were carefully devised, and for an indefinite time continuously operative.

At this time I was closely tied to a provincial town, and had little opportunity for consultation with leading men of science; but amongst the few who influenced my determination was the late Chas. Darwin. He had shown great interest, and given me great encouragement in prosecuting the life-histories; and in correspondence, amongst other things, I gave him details of the imperfect but still interesting results I had obtained by thermal experiments on these forms, and the preparations I was making for systematic inquiry in that direction. After words all too generous, he said in his reply, which was dated July 2nd, 1878, "I did not know that you were attending to the mutation of the lower organisms under changed conditions of life; and your results, I have no doubt, will be extremely curious and valuable. The fact

which you mention about their being adapted to certain temperatures, but becoming gradually accustomed to much higher ones, is very remarkable. It explains the existence of algæ in hot springs. How extremely interesting an examination under high powers on the spot, of the mud of such springs would be."

Shortly after this I brought my tentative and experimental work to a close, and commenced the course of observations I shall here detail.

I need not remind you that all biological changes must be slow. Variations are constant, of that there can be no doubt; and under domestication they are very palpably increased and conserved.

But the smallness of every variation, as a rule, and the relative fewness of the generations that come into existence, even of prolific animals and plants during the working life of an observer, to say nothing of the difficulties that would present themselves in other ways, make anything like individual observation on visible forms under experiment almost impossible and hopeless.

Save for the useful and remarkable modifications effected in animals and plants under domestication, the great process of biological progression, made clear to us by Darwin, is essentially a secular one, and is comparable to the vast secular processes of astronomy, such as the precession of the equinoxes; which, although we have observed but a minute fraction of the complete cycle of movement, leaves us as certain of what that cycle is as though we had traversed its immense circumference under continuous observation.

But this very fact, as in astronomy, so in biology, makes any observed facts that may come within our reach, or be possible to our laboratories, of even enhanced value.

Now in the Infusoria—say the septic organisms—the cycle of life is so relatively short, and the generations succeed each other so rapidly, while the successive progenies can be so easily observed, that if we can devise apparatus and conditions which will enable us to institute slow changes of environment, we should be able to observe critically how far changes in the organisms led to responsive adaptations and successive survival. At the same time it would be possible to closely investigate the condition and appearance of the organisms themselves.

To know the living forms under experiment, through all the changes of their life-cycle, was therefore important; and I chose such of the monads whose life-history I had worked out, as were most easily obtainable and most abundant.

Every ingenious mind will have its own suggestion for the modification of the environment of such organisms; but after the tentative work I had already done, and in view of the fact that at that time the question of the influence of heat on this whole series of putrefactive organisms was being eagerly discussed, I determined finally to make cumulative increments of heat the means of adverse environment; I wanted therefore a delicate thermostat, that should be capable of alteration at will to the temperature at which it should again become static.

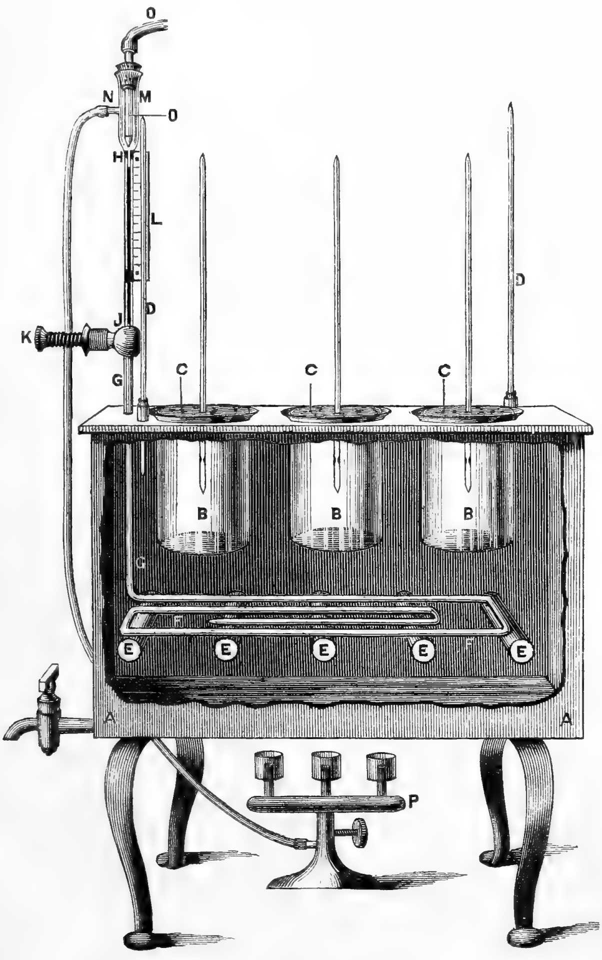
After I had made a considerable number of preliminary experiments, and had been aided by suggestions, especially from my friend Mr. Joseph

Swan, my ideas were carried out by Messrs. Elliott Bros., of this city, who, early in 1879, furnished me with an apparatus that completely met my want.

The ingenious device of Prof. Schäfer for maintaining a constant temperature in a warm stage for the Microscope, published in 1874,* formed the foundation of my arrangement.

A drawing of the apparatus is given in fig. 31. A A is a large

Fig. 31.



strong copper vessel with a jacket of felt, containing water. In the drawing the nearest side is supposed to be removed to show the interior. B B B are three vessels containing the putrefactive fluids and organisms.

* Quart. Journ. Micr. Sci., xiv. (1874) p. 394.

These are of glass and are immersed in the water. In the upper rims of these vessels, which are outside the copper container, C C C are loosely fitting cork tops, in the centre of which delicate thermometers are fixed, so as to have their bulbs plunged into the putrefactive fluid. D D are two thermometers of a similar kind placed in the water of the copper vessel to register its temperature. E E E E E are copper tubes fixed across the copper vessel, some distance from the bottom, to form a firm support for the glass tube " gridiron " F F ; this is continuous with the tube G G, and is filled, from somewhere near H, throughout all its length, with about ten pounds of mercury. The bulb J is also full of mercury, and K is a steel screw plunger, which by being screwed in or out can raise or lower the column of mercury above it. L is an ivory index of the height of the mercury. M is a chamber larger than the general tube G, and has a rectangular arm N; into M is fixed by a cork, air-tight, a smaller tube O; this is in direct communication with the gasometer. In the bottom of this tube is fixed a tube of platinum, which " wets " with mercury, making a sort of contact, but not an amalgam.

From the tube N proceeds all the gas that supplies the burner P. The gas therefore, coming in at O O, finds its way out between the bottom of the tube O, and the top of the mercury, into the tube H, and so to the burner.

When the right point of temperature is attained, the steel plunger K is screwed in until the mercury is close to contact with the platinum; and by about an hour or so of watching and manipulation the temperature is made static at the point required, for if the heat become slightly higher than it should be, the mercury, by touching the platinum, stops the supply of gas; and the gas would go out, but that a very small hole is pierced in the platinum of the tube O opposite H, which, when the platinum and mercury are in contact, sends enough gas to the burners to keep up a flame in each, of more or less diminished intensity as the nature of the case requires. Hence, with a smaller heating power in the burners, the temperature falls very slightly; and so does the column of mercury: by this means the amount of gas sent to the burner is increased, the heat is again raised a minute fraction, and thus, within a quarter of a degree Fahr., the fluids may be kept at a fixed temperature, which is none the less variable at will.

Two essentials are involved in the delicate working of this instrument; the first, especially with the lower grades of temperature, is a room which shall be of a constantly even temperature; and second, gas for consumption at an unchanging pressure.

This latter is now so comparatively easy of accomplishment, by several useful instruments, such as Moitessier's gas pressure regulator, that it is needless to burden you with details of the less elegant and more laborious method which I employed in the earlier days. They were, however, quite efficient, and I have now two thermostats at work on this matter in which the variation is less than a sixth of a degree Fahr. in twenty-four hours.

For greater accuracy in action it is well to have several small Bunsen burners grouped, each with a separate stop tap, and the whole capable of

being racked up and down by a milled head. We thus control the heat accurately. The flames should be guarded by small glass cylinders. Moreover, for low temperatures it is needful to be able to control the amount of gas which shall be the minimum amount when the mercury has risen to block out the main supply; this I have accomplished by means of a collar of diaphragms seen in figs. 32 and 33. In A the end of the glass tube bringing the gas into the instrument is shown, viz. O of fig. 31. C of fig. 32 is the platinum tube which makes contact with the mercury; it is best for its end to be at an angle; it cuts the gas off more gradually. E is the aperture through which gas goes out when the tube is blocked with mercury. Now it is needful to have the amount of this under control. This is done by a collar of diaphragms, seen at F in B, fig. 33, which is placed upon the platinum tube D. There are different sized apertures in this collar, as G, H, I, and the hole E in A being made as large as the largest in the collar, and the collar revolving gas-tight, we can use at will a larger or a smaller aperture.

Fig. 32.

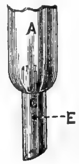
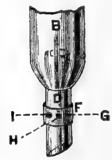


Fig. 33.



By a simple arrangement, which I have already for another purpose exhibited and explained to this Society,* I constructed a warm stage fitted to a suitable Microscope, which was attached to the large water vessel of the thermostat, by tubes, so that the water in the vessel was kept in constant circulation in the stage, and by this means I could examine the organisms in the glass vessels at the temperature at which they were living.

I confined my attention to three well-known organisms, whose life-cycles I fully understood, and had completely followed. They were those which Mr. Saville Kent has named *Tetramitus rostratus, Monas Dallingeri,* and *D. Drysdali.* Of course, beyond these there were a large number of putrefactive forms in great abundance, such as *Bacterium termo, B. lineola, Spirillum volutans,* and other forms of monads. But my attention was confined wholly to the three specified organisms.

I resolved on using very minute increments of heat very slowly. I commenced at a normal temperature of 60° Fahr., and the first four months were employed in raising the temperature 10°. This, by control experiments, I found to be quite unnecessary in itself, for even a relatively very rapid rise from 60° to 70° Fahr. will quicken the multiplying power of these organisms.

But also, by rough control experiments, I learned that the more slowly and regularly the first increments of heat, between 60° and 70°, were superimposed, the greater safety was there in slow progressive advance.

But no discoverable change took place during this time. The normal processes went on in a normal way. The organisms were extremely abundant; fission occupied the same time, and occurred at the same intervals; while the spore-sacs, resulting from the blending of two forms, were as we have always seen and described them.

At every successive access of heat I made very critical examinations, not only of the morphological details, but also of the condition of the

* Cf. *infra*, p. 317.

sarcode of the body. But I discovered absolutely no noticeable divergence from the normal state.

In the first two months I elevated the temperature six degrees; and during the next two months two degrees per month.

It is extremely difficult to judge of such a matter, but there appeared to me evidence that from the 68° to the 70° there was possibly a quickened and enlarged productiveness. But there was no way of demonstrating this; and if this were so, when at the expiration of another month I raised the temperature a degree, I had reason to suspect adverse influence on the organisms; and this became manifest two months after, when the temperature was raised to 73°. There was a great falling off in members in the field. From whatever part of the containing vessel a minute speck was taken for examination, it was palpable without any exact numerical estimate that each of the organisms were fewer in number, while many died under examination upon the warm stage.

On submitting them to critical examination I could discover no change, save that even the healthy and active ones were not quite so vigorous as in earlier stages.

This was the state of things immediately upon elevating the temperature to the point named. And this continued for the next few days, and I began to contemplate a move backwards of as small a portion of a degree as I could accomplish; but the diminution was not continuous after a week, and I left the temperature untouched. It was static at this point for two months, and during this time the vital vigour and all the vital activities of the organisms were regained. I then ventured to raise the temperature to 74°; at the end of twelve hours there was a visibly adverse influence, but not so marked as before, nor so long continued. In four days there was a complete restoration of the vigorous condition.

At this point I left it static for six weeks and then commenced to try to raise the thermal point; the greatest caution had to be used, for although no immediate effect was visible in the course of a day, or at farthest two days, if an excessive or too hasty increment of heat had been added torpor became everywhere visible, and a total collapse was threatened. But in the course of five months I advanced from 74° to 78°.

But here a critical point was manifestly reached, for they began in large numbers to succumb; and it was only by altering the temperature backwards and forwards between 77° and 78° for several weeks, that I was able to get the three forms under examination to rest in fairly healthy vigour at 78°.

Beyond this point I could not elevate the heat even half a degree without very visible evil influence, for eight months. During that time repeated attempts were made, but with what at first threatened to be fatal results; only the longer they remained at 78° the less injured were they by the heat increment.

During this time I watched with all the care I could command the processes of sporing, growth and fission, which presented no unusual feature; and I also, with all the best aids in light and lenses which I could get, searched for any modifications in the sarcode.

For the first two months nothing that I could really be sure of was visible to indicate such change; but *M. Dallingeri* has the peculiarity of being almost entirely, in the normal state, free from vacuoles in the sarcode. I had noted and drawn the other forms several times much more vacuolated than was usual; but I now, at between two and three months after 78° had been reached, observed frequently that *T. rostratus* and *D. Drysdali* were also vacuolated; and in the course of a month this was not only abundant, but far more the rule than the exception.

In figs. 1, 2, 3, plate VI., are presented fair average drawings of the three forms in their normal condition, and in figs. 4, 5, 6, 7, and 8, 9, 10, 11, and 12, 13, 14, 15 are shown the successive states presented by average specimens, taken in the case of each monad during the fourth and fifth months after being static at 78° Fahr.

This vacuolation was not necessarily permanent. The vacuoles could often be seen to gradually get nearer to each other and unite into a larger one; and in the process of fission the vacuoles would often divide, and in some cases partly, or even wholly, disappear. But in a sexual fusion of two forms all this vacuolation disappeared, and the sac presented a perfectly normal condition.

After the fifth month I found, on careful trial, that I could without much discoverable inconvenience to the organisms raise the temperature a degree, and in the course of three months, by very delicate increments, I had reached 80°.

During this time the vacuolation, which was, as I have said, no proper feature of these forms as I knew them at normal temperatures, disappeared very gradually, and they were, in condition, form, and activity, much as they were at 60°.

The advance from this point had to be gradual; either too large an increment, or too short an interval of time, again wrought visible damage, and had to be at once corrected; but as the temperature advanced, there was no alteration anywhere perceptible in the sarcode of the organisms; nor did they alter in the least as to the details of fission or sexual fusion. The time occupied and the manner were as described for ordinary temperatures.

By very slow elevation of temperature, extending over nearly nine months, I reached 93°, and during all this time I could detect no divergence from the same organisms when seen at 60° Fahr. They resented a too rapid elevation of temperature, and I had constantly to return to the last static point for longer or shorter periods before a sure advance was made. It was evident that a physiological adjustment had to be brought about, adapting the organisms to each fresh elevation of the thermostat, before any successful progression could be made.

But beyond the point of 93° I could not go without causing all three of the monads to surrender to torpor and death, until I had submitted to what proved to be a prolonged continuance of the static 93°.

I tried to elevate the heat by most delicate advances, the smallest fraction of a degree of which the apparatus was susceptible, at intervals of one month for three months successively, but with such adverse results, visible in a couple of hours, as made it necessary to go back to a lower point than 93° in order to restore complete vigour.

But during this time I began to discover a renewed tendency to vacuolation. In this instance it commenced in very minute vacuoles, and they were sparsely distributed, but in each of the three monads steadily increased in number, but did not, as in the former instance, fuse into larger vacuoles, but only increased in number. In figs. 16, 18, 20, are drawings of *M. Dallingeri*, *D. Drysdali*, and *T. rostratus*, as they were in the fourth month with a static temperature of 93°, while figs. 17, 19, 21, show corresponding organisms at the end of the fifth month, under the same circumstances. This represents the extreme state of vacuolation attained, and at the end of the ninth month, and not until then, was I able to elevate the temperature of the fluid a degree. But in the course of three weeks at 94° they became perfectly normal, lost all trace of vacuolation, and were most active and prolific, and submitted without great inconvenience to an elevation of temperature up to 102° in fourteen weeks.

After this there was a slightly increasing difficulty until I reached 107° which took two months, and there another pause ensued. During the next three months a relatively slight vacuolation took place, and permitted a further addition to the temperature until after seven months more, with smooth careful progress I reached 137°.

This appeared to be a very critical point, for directly the 136th degree had been passed there were symptoms of oppression and distress, and on touching 137° this was very manifest.

I was compelled to play the thermal point back and forward for three weeks before there was an approach to normal activity and fecundity, but beyond this point I dared not advance.

In putting a drop, for example, upon a thermal stage, at the point 136°, and then elevating it slowly through 137° to 138°, torpor became universal in all the three organisms in the field.

My only hope of further advance was in patience.

After six months of constant and careful endeavour, not the slightest advance appeared to be made. There was no greater readiness than before, and I began to despair of further success, no vacuolation or any other feature that could be noted was discoverable. In this way I continued the observations, with constant test experiments for twelve months, and with no apparent advance.

But at the end of this time I saw that a slight tendency to endurance of a minute elevation towards 138° was visible, and with it a rapidly increasing growth of vacuoles, which spread as before through the sarcode of each of the three forms, but the tendency was for these to pass from small into large vacuolations. In a month these were universal, and in figs. 22, 23, 24, 25, I have drawn successive stages of this condition, as they appeared in one month from the beginning of the process.

During this time I had been able to raise the temperature 4°, and the vacuolation disappeared rapidly. The progress was now as rapid as it had been slow previously, and admitted of as much as 2° elevation at a time, and without further difficulty I slowly progressed to 150°, more slowly to 155°, and was again brought to a dead standstill at 158°.

Here, with such pain as I presume is natural, I have to close the

story. The accident happened, destroying the use of the instrument, and causing the whole to collapse.

I preserved the sediment of my vessels, and have, as I have said, begun the work again, and with precautions and suggestions begotten of experience, that I can only hope may not make that experience after all dearly bought.

But it is a matter of interest to know, that although I did not succeed in raising the temperature in these forms to anything like the elevations that the algæ and other low forms have been found in nature to flourish in, yet there seems to be indicated in these observations, imperfect as they are, that there is at certain points in the endurance of cumulative thermal elevations, a distinct physiological change brought about with greater or less difficulty, which seems to be directly correlated to the power of adaptation to a given measure of heat increment. It is not a quiet rhythmic progression. There are points of greater and of less difficulty.

How far these may be capable of association with certain chemical and physical, or even physiological conditions I do not pretend to say, nor do I wish to draw any general inference as to even this *group* of organisms. My observations were only on these three special forms. But the fact is suggestive, and it is the more so when taken in relation with an additional fact.

These organisms and their congeners generally, of the septic group, flourish at 65°, and are killed at 140° Fahr.

But if the adapted organisms at 158° F. were taken from that temperature and placed in an eminently nutritious and suitable nutritive fluid at 60° they died. While, of course, if forms of the same kind exactly, living and flourishing at 60°, were placed in a nutritive sterilized fluid at even 150° they were finally destroyed.

I can only claim for this fragment its suggestiveness, and its possible value as an incentive to others to treat the lower and minuter forms of life in corresponding manners, and as showing that such work cannot be without value.

VI.—*On Cutting Sections of Sponges and other similar structures with soft and hard tissues.*

By Dr. H. J. Johnston-Lavis, F.G.S., and Dr. G. C. J. Vosmaer.

(*Read 9th March*, 1887.)

The difficulties that are involved in the study of structures where the component tissues have different physical or chemical properties, are such that in some cases the histological or anatomical arrangement has never been thoroughly understood. Perhaps there is no better example of the above difficulties to be found than the Porifera, in which the biologist has to contend with a very complex intermingling of hard and soft substances of entirely different chemical as well as physical properties. We have, in fact, a remarkably delicate protoplasm enwrapping various complicate spicules and granules of siliceous nature. Although many sponges only possess a few spicules, there are others the skeleton of which is so extremely hard that it is utterly impossible to cut through them with the ordinary cutting instruments. It is true sections have been made, even of very hard sponges, but then only relatively small ones can be obtained; it is, however, an obvious advantage to be able to cut large sections, in order to be better able to study the relation between the canal system and the skeleton.

Thinking over the mechanical difficulties that thus hinder success, the true solution of the problem is obviously based on a suitable method of equalizing the hardness of the two substances composing a sponge, and which practically consists in rendering the sarcode sufficiently hard and cohesive to withstand the mechanical treatment necessary in cutting the hard siliceous spicules, of retaining all their structure in their relative position, and at the same time not to destroy or even change the histological characters of the most delicate tissue.

With this object Prof. Sollas has succeeded in making sections through hard siliceous sponges by means of the freezing microtome. The objections to the method are manifold—the difficulty of keeping the temperature low, and manipulating under such conditions—the comparatively small increase in the cohesion of the sarcode.

The method employed by Prof. Von Koch for corals has the great disadvantage of taking too much time if one wishes to make rather large sections; besides, copal is a substance of which it is difficult to make clear solutions of different strengths.

Marshall's note about plunging the sponge into boiling Canada balsam shows much of the skeleton and some parts of the canal system, even now and then something of the tissues, but the method is too rough.

The method we now describe fulfils all the necessary conditions, and is capable of being used with the most delicate stains and of affording complete and entire sections of unlimited size, results almost impossible with soft though tenacious tissues. The only objection that can be urged against our method is that it is somewhat tedious, but in this it has great

advantages over Koch's method, and is not much longer than the sectionizing of pumice-stone devised by the first-named of the authors of this paper.* In fact this process was suggested to us by this latter method combined with that of Prof. O. Sankey, which most beautifully demonstrates how even a tissue like the brain, with its delicate cells and nerve-filaments, can withstand drying.

The method we now describe has the following points in its favour:—it renders the protoplasm sufficiently hard to be treated as fossil sponges; it does not destroy histological details more than a paraffin imbedding; it permits the making of sections of unlimited size; every spicule or other unfixed object remains in its place. The objections to it are its somewhat tedious character, requiring patience and a certain amount of skill and ingenuity in carrying out the various operations; but after all, this equally applies to all methods.

The materials required are, besides the specimens and staining materials, Canada balsam dissolved in benzole, a thick and a very thin solution, hard balsam such as is used in cutting rock sections, a grindstone with a flat side,† and a good-sized hone, say $2\frac{1}{2} \times 1\frac{1}{2} \times 8$ in., a solution of soap in equal parts of alcohol and water, and a small stream of clean water.

A thin slice is cut with a very sharp thin knife from the whole or part of a sponge hardened in absolute alcohol of a thickness of from two to five lines, according to the size and structure of the specimen. This, after the usual staining process, is returned to absolute alcohol and a few drops of benzole are added; after an hour some more benzole, and so on. The next day the object may be placed in pure benzole. If one adds the benzole too quickly the object shrinks and is spoiled.

From the benzole it is transferred either into the benzole-balsam solution or lumps of balsam are added to the benzole bath in which it was. The quantity of the balsam is either increased by the use of a more concentrated solution or by adding more hard.

After the object is well penetrated it may be dried in the air for one day, after which it is transferred to a kind of hot-air bath, of which we give a sketch and description. Provided the tissues are thoroughly penetrated by the balsam, they can withstand complete drying up, and even in order to accelerate the process, they can be exposed to a temperature of 80° C. or more. Usually after some days, or in the case of large objects after some weeks, the section is hard enough for grinding. In order to be successful it is necessary to see that balsam fills every hole, and if such is not the case, to apply some thick solution which may be used warmed. If, on commencing to grind, as it will sometimes occur, that the balsam is not hard everywhere, or even if one can make an impression with the nail, it must be returned to the oven. To prevent fracturing in consequence of the balsam being unannealed, it is advisable to gradually lower the temperature toward the end of drying. In cases of very large slices it is convenient to bring them in complete contact with the surface of the glass slips upon which the specimens are

* See this Journal, 1886, p. 22.

† An ordinary grindstone trimmed with an old file, or a piece of flat sandstone answers very well.

drying, so that this may act as a support whilst one side is being ground down. Short corks may be attached by means of marine glue to each end of the slide, so as to afford a firm hold.

We are now in possession of a hard mass, the future treatment of which resembles that by which a piece of pumice is sectionized by the first author's method. The fragment if large must, as already has been mentioned, be attached during drying to a piece of glass, but if of fair thickness a section two centimetres or three-quarters of an inch may be held in the fingers. The flatter or more complete side is held against the side of a grindstone, or rubbed in a circular manner on a flat slab of the same material until a fairly level surface has been obtained. A small quantity of carbonate of soda or, better, soap solution may be added to the water, to prevent the stone clogging with the balsam and tissue ground off. The quantity requires careful watching to prevent dissolving more balsam than is ground off, in which case the section will appear cloudy when finished.

After washing, the ground face is now applied to the hone and a drop of the solution of soap in alcohol and water is to be put upon the nearly level surface of the stone upon which water is slowly dropping. The grinding is now continued until a fine level surface has been obtained. From time to time the object will begin to catch on the stone and little rolls of balsam form, which is an indication for more soap solution. When a perfectly level smooth surface has been obtained, the object is washed in clean water with a soft tooth-brush or a camel's hair pencil, dried and warmed just sufficiently to drive out any moisture in cracks or cavities, *but not to soften the balsam.*

The permanent glass slip is now cleaned with alcohol and varnished with oil of cloves (slightly grinding the surface is sometimes useful in order to make the object stick to the glass), then heated and rubbed with perfectly hard balsam, so as to leave a thin layer of this substance covering the slip. The ground face of the specimen is also very thinly varnished with oil of cloves, and pressed into the warm balsam so as to come in complete contact with the glass, avoiding air-bubbles, &c. Large sections can rarely be fixed at once in this way, therefore they are put on a piece of paper which lies on an elastic mass, such as some sheets of paper, a piece of indiarubber, &c., and the glass touched by the flame opposite points where the object is not yet fixed, pressing it into contact at every point. The preparation is now allowed to *cool very gradually* to anneal the balsam.

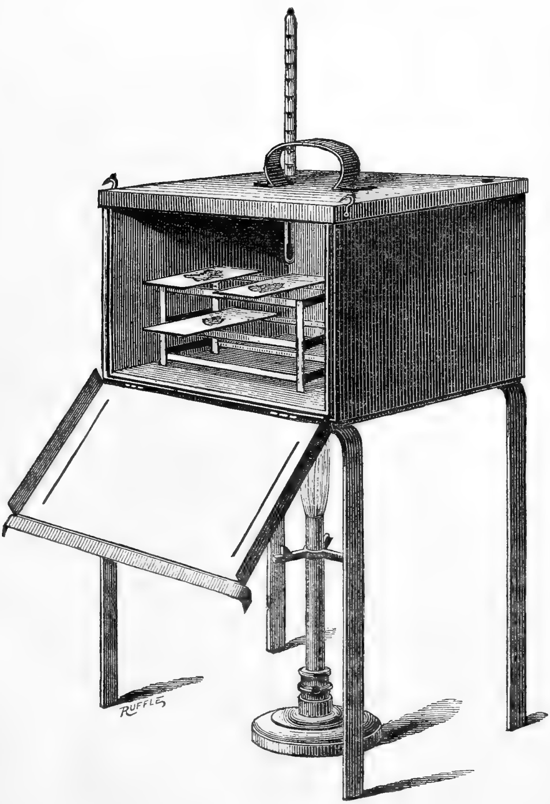
The object is now brought against the circumference of the grindstone, and the thickness reduced all over. When we have removed as much as convenient, the flat side of the stone may be used and the preparation levelled down to almost the requisite thinness for microscopical examination. It is now transferred, after washing, to the hone for the final grinding, which requires great care and gentleness to prevent the edges of the section cracking away. If such is persistently the case in some examples the mass may after the stoving be enveloped in plaster strengthened by threads, a method suggested by Prof. Von Koch. When the desired thinnesss is acquired the section is again thoroughly washed in water with the aid of a brush, and spontaneously dried. When

dry it is washed with chloroform, benzole, or turpentine and finally mounted in balsam as an ordinary section.

The method will strike the reader as a long one, tedious, and open to failure in consequence of the number of different processes involved; but by preparing a number at once much time is saved, and one failure prevents our exposing ourselves to a repetition by teaching us in what way we have erred. At any rate the whole goes quicker than Von Koch's method and does not injure the object as in the too rapid method of putting the object into boiling balsam. We have succeeded in making large sections of the very hardest sponges, showing most of the cells as little altered as in paraffin-prepared objects, and in one case the preparation includes a section through a gasteropod shell. It is possible to make sections of an unlimited size, a great advantage for studying the relationship between the canal-system and the skeleton.

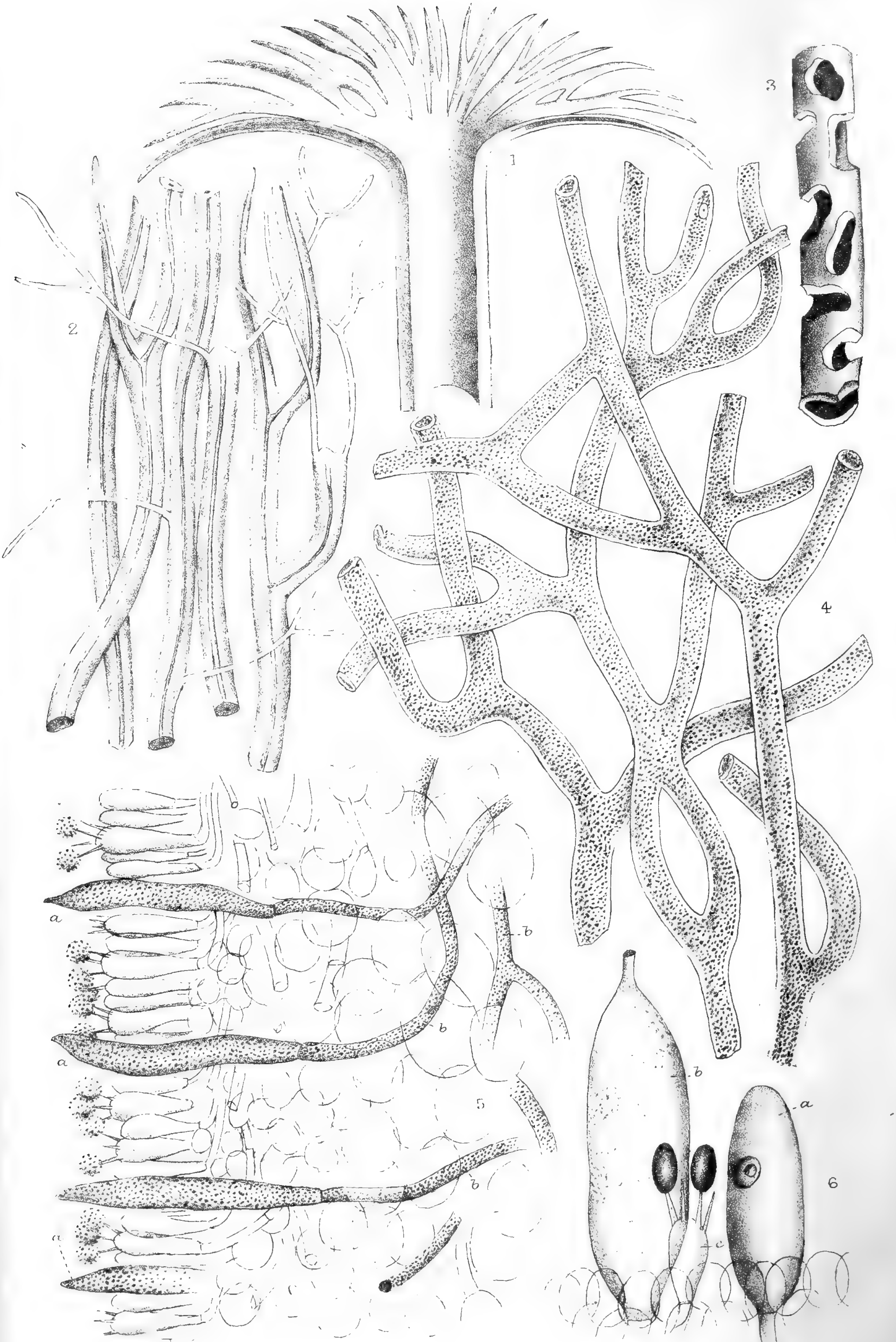
We have still to describe the little oven constructed by the second-

Fig. 34.



named author. This oven (fig. 34) consists of a brass box the inner walls of which are lined by asbestos cardboard, whilst the bottom is

alone of this latter material, so that we may produce a very equal heating from all sides of the sponge preparations. On one side of the oven is a door which flaps downwards, whilst the cover also is made to flap backwards. Through the latter a thermometer and if desired a regulator may be put as in an ordinary chemical hot oven. The whole is supported on metal legs of a convenient height. Within is a metal rack with shelves at different heights; the slides or preparations are placed for the first few days on the top shelf and are afterwards gradually lowered.



G.M. del ad nat. West, Newman & Co. lith.

Illustrating Mr Massee's paper on Tissues in Fungi.

VII.—*On the Differentiation of Tissues in Fungi.*

By George Massee, F.R.M.S.

(*Read 9th March*, 1887.)

Plate VII.

In the Rev. M. J. Berkeley's collection of fungi, now in the Kew Herbarium, is a specimen marked "*Polyporus pisochapani* Nees." The plant is old and brittle, part of its substance having been reduced to powder by minute fungus-eating beetles; nevertheless, the fact of its being in this condition constitutes its special value in connection with the present subject, that of illustrating in a marked manner the sharp differentiation of its component hyphæ into two distinct systems, mechanical and reproductive. The first, being most durable, is almost intact; the latter much decayed, yet sufficient remaining to show clearly its original arrangement. The mechanical component forms an unbroken hollow cylinder in the stem near to its periphery; its substance is about half a line thick, and is surrounded at some little distance by the indurated cuticle. At the apex of the stem this tube widens out into a funnel-shaped body, which becomes broken up into a number of ribs, radiating from the central portion to the margin of the pileus. The substance of the stem portion of this mechanical sheath is solid, and in the dry state as hard as cocoa-nut shell, but the ribs or radiating portions of the pileus are hollow, taper to a fine point, and are sometimes connected by transverse bars. The pileus, like the stem, is covered with a cuticle.

Examined microscopically, the mechanical ring is seen to be composed of eseptate hyphæ of a rich brown colour, and with very thick walls; in fact the cavity is in most cases obsolete. In the centre of the ring the hyphæ are rarely branched, closely compacted, and often more or less polygonal in section from mutual pressure. Towards the outside the hyphæ are frequently branched, the larger branches being mostly vertical and terminating abruptly in from two to several slender filaments spreading in a flabellate manner. Numerous small branches also originate from various points throughout the length of the large hyphæ, more especially those situated on the peripheral side of the strengthening ring; these small hyphæ, by repeated branching, form a plexus which becomes very intricate and densely compacted on the

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EXPLANATION OF PLATE VII.

Fig. 1.—Portion of mechanical sheath of stem and pileus in *Polyporus pisochapani*; natural size.

Fig. 2.—Hyphæ from peripheral part of mechanical sheath of stem of *P. pisochapani*; × 400 diam.

Fig. 3.—Portion of mechanical sheath from stem of *P. rugosus*; natural size.

Fig. 4.—Laticiferous vessels from stem of *Lactarius torminosus*; × 500 diam.

Fig. 5.—Portion of transverse section through gill of *Russula fœtens*; *a a*, cystidia continuous with *b b*, laticiferous vessels; × 500 diam.

Fig. 6.—Portion of margin of gill of *Coprinus atramentarius*, showing a young cystidium with hyaline protoplasm and a nucleus at *a*; *b*. an old cystidium; *c*, a basidium with four spicules or spore-bearers: only two of the spores are shown.

outside forming the cuticle, where, owing to the diffluent walls, the threads are agglutinated together, and form a hard brittle crust when dry. The thick hyphæ forming the framework of the pileus also give origin to fine lateral branches, which are at first but little compacted, but eventually become densely felted, and form the cuticle of the pileus. A few small branches, springing from the hyphæ situated on the inside of the thickening ring, form a loose framework in the hollow of the stem; a similar framework originates from the under side of the strengthening rays of the pileus. The structures already described are purely mechanical or protective in function, and consist entirely of very thick-walled, eseptate hyphæ. The second or reproductive portion, on the contrary, is composed of very thin-walled septate threads, generally copiously branched, forming compact but not hardened masses, except in the hymenium or spore-bearing portion. This latter system occupies the central cavity of the stem within the mechanical ring, from which it extends through the framework between the ribs and the cuticle of the pileus, forming the so-called flesh, then passes down between the ribs and gives origin to the porous hymenium.

There is no evidence of any organic connection between the hyphæ of the two systems, in either stem or pileus; and in all probability, differentiation takes place before the plant emerges from its vegetative mycelium.

Polyporus pisochapani * has a pileus about three inches across, a central stem about four inches long and more than half an inch thick. Other species of *Polyporus* in the same collection, in a more or less decayed condition, show a similar differentiation of tissues. *P. rugosus* Nees has the mechanical sheath of the stem irregularly perforated, while in *P. lepideus* Fr. and *P. floccopus* Rostk., the corresponding portion of the pileus consists of a perforated plate, which sometimes shows a tendency to become broken up into ribs, as in *P. pisochapani.*

No member of the Agaricini, so far as I have been able to ascertain, shows such a marked division of labour amongst its component hyphæ for purposes of support; nevertheless, in most species, there is a well marked cuticle to the pileus composed of slender felted hyphæ, and the stem generally becomes hollow with age, a firmer peripheral portion remaining, which probably corresponds to the more highly developed mechanical sheath in the stem of *Polyporus.* If however, the supporting hyphæ differ but little from those concerned with reproduction in the gill-bearing agarics, we find in some genera, as *Lactarius* and *Russula,* a highly specialized laticiferous tissue, which is distinct from the earlier stage of development. The vessels of this system generally form bundles in the peripheral portion of the stem, from whence they pass into the pileus and gills. In *Lactarius* two types of structure occur; the vessels are the result of cell-fusion, only few of the transverse septa remaining, as in *L. deliciosus;* † or they consist from the first of eseptate hyphæ, much branched and frequently

* *P. pisochapani* Nees = *P. amboinensis* Fr. 'Grevillea,' xv. (1886) p. 58.

† For detailed description of the laticiferous system in this fungus, see Prof. A. Weiss, SB. K. Akad. Wiss. Wien, xci. (1885) pp. 166–202 (4 pls.).

anastomosing, as in *L. torminosus;* the last type is most general. The latex consists of exceedingly minute granules floating in liquid, and is always colourless (white) when in the tissues, but on escaping into the air frequently changes colour, becoming red in *L. deliciosus,* lilac in *L. uvidus,* and golden yellow in *L. chrysorrheus.* The colour is due to some change taking place in the granular portion, the liquid remaining colourless.

The walls of the vessels are exceedingly thin in the species of *Lactarius,* and liberate the latex or "milk" on the slightest touch.

This tissue is undoubtedly connected with nutrition, or the transportation of food-material, in the form of *glycogen,* which is considered by Errera * to be of the same value in the nutrition of fungi as starch is in chlorophyllose plants, and the reagents enumerated by this author show that glycogen abounds in laticiferous vessels. In studying this system, or testing for glycogen in species of *Lactarius,* it is advisable to allow the plants to remain for a few days in a dry place, during which time the more liquid portion of the latex evaporates, and sections can then be cut without further loss of this substance, which in fresh plants flows from the vessels at once, when injured; neither is the reaction so evident in fresh as in dried specimens. If sections from plants prepared as above are slightly warmed in a solution of iodide (water, 45 grm.; potassic iodide, 0·3 grm.; iodine, 0·1 grm.) those parts containing glycogen assume a dark orange or reddish-brown colour, depending on the quantity present; the colour becomes paler when heated to between 50°–60° C., and returns on cooling. In such preparations the laticiferous vessels stand out as dark-brown lines. In the genus *Russula* the liquid portion of the latex is scanty, so that it does not flow from the vessels when cut; nevertheless the contents assume a dark reddish-brown colour when treated with iodine as above, and in *R. fœtens* Fr., by means of this method of staining, I have satisfied myself by repeated observations that the cystidia met with in the hymenium of most, if not all, gill-bearing fungi are simply the terminal cells of laticiferous vessels. These bodies, on account of their large size and peculiar properties, have been the subject of much controversy and speculation: † by de Seynes ‡ considered as aborted basidia; by others, as Corda, Hoffmann,§ and more recently by Worthington G. Smith,‖ as male reproductive organs; hence the names *pollinaria* and *spermatia* applied to them. Cystidia are very numerous in the hymenium of some species of fungi, rare in others, and in some perhaps altogether absent; but in connection with this question I cannot do better than give an extract from the article by W. G. Smith already quoted:—"The receipt of the magnificent specimens of *Agaricus bombycinus* from your correspondent the Rev. J. M. Du Port, has again directed my attention to the subject of cystidia in agarics. Knowing by experience how fine the cystidia are in some near allies of

* Mem. Acad. R. Sci. Belg., xxxvii. (1885) and Bot. Zeit., xliv. (1886).

† A. De Bary, "Morphologie und Physiologie der Pilze" in 'Hofmeister's Handbuch,' ii. (1886) cap. v. Translated in 'Grevillea,' i. (1873), p. 181.

‡ 'Essai d'une Flore mycologique de la région de Montpellier,' Paris, 1883.

§ "Die Pollinarien und Spermatien von *Agaricus*," Bot. Ztg., xiv. (1856) pp. 137–48, 153–63.

‖ 'Grevillea,' x. (1881), p. 77, and 'Gardeners' Chronicle,' Sept. 17, 1881, p. 369.

A. bombycinus, the first thing I did on receipt of the specimens was to look for the cystidia. For several hours of the night my efforts to find anything were unavailing; at last I saw one, soon afterwards two others (in the hymenium), at length two more; they all agreed exactly in their great size (longer than any here illustrated), in their spindle shape, and in being without spicules at the summit. The cystidia must be extremely rare in *A. bombycinus,* and this fact will give some one a good opportunity for saying he cannot see them, or for some rash person to deny their existence altogether." In a section of the hymenium these bodies, when present, are easily known by their large size, usually projecting much beyond the basidia with their spicules and spores. When young the cystidia, which may be considered as the growing points of latex vessels or hyphæ, contain hyaline protoplasm and a large nucleus with a nucleolus—corresponding to the nuclei present in other parts of the laticiferous system—but when they have attained their full size the protoplasm is replaced by a finely granular substance containing glycogen, which eventually escapes through a nipple-like or filiform attenuation at the apex of the cystidium. In some species four or more of these attenuations are present, and arranged in a similar manner to the spicules surmounting a basidium, which has led to the idea on the part of some that cystidia may be abortive basidia. In the young hymenium cystidia may be met with in all stages of development, and are always cut off by a septum from the vessels they terminate, at which point they break away and drop off after the escape of their contents. As to their function, nothing definite can be stated, but I am inclined to believe that their contents are poured out for the purpose of supplying a certain amount of food to the developing spores, which in many species are bathed with it during growth.

Laticiferous vessels are by no means confined to the above-named genera, but are widely distributed throughout the order, being especially well developed, and containing abundance of latex, in *Peziza saniosa* Fr. Neither do I consider the whole of the latex as consisting of glycogen, but that it is present in the laticiferous vessels along with other substances, being especially abundant during the early stages of the plant's development, and replaced later on by a substance assuming a blackish-brown colour with iodine or dilute sulphuric acid, which does not change when heated.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Germinal Layers.‡—Dr. W. Wolff communicates a critical historical review of the progress of knowledge from Pander onwards in regard to the history of the germinal layers. He travels over somewhat familiar ground in his account of gastrulation and the like, and gives expression to several opinions which hardly seem to have been sufficiently focused. The principal point in his article is his insistance that the mesoderm, or Mittelkeim as he prefers to call it, cannot be said to arise from the endoderm. The constituent cells have an independent pre-endodermic origin, and represent the surplus of segmentation cells not used in forming the gastrula. It might be argued that whatever be the sphere of *à priori* speculation, embryological generalizations should be kept in as close touch as possible with known facts.

Karyoplasm and Inheritance.§—Prof. A. Kölliker has some remarks on the theory of Prof. Weismann with regard to the continuity of germ-plasma. He urges that the idioplasm found in the nucleus of the fertilized egg-cell increases in size during the course of development, but passes with its internal structure unaltered into the nuclei of all the cells which take part in the formation of the embryo; and he denies, consequently, the fundamental difference which is asserted to exist between somatic cells and those of the tissues on the one hand, and the ovarian and seminal cells on the other. He asserts that in the metamorphoses of the embryonic cells into the specific elements of the tissues the primitive nuclear idioplasm often completely retains its typical peculiarities, but in other cases retrogression takes place and this idioplasm disappears.

Prof. Kölliker's idea about the structure of idioplasm is this: we cannot doubt that the basis for the whole organization of the future

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Arch. f. Mikr. Anat., xxviii. (1886) pp. 425–48 (1 pl.).

§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 228–38.

creature is contained in the idioplasm of the fertilized egg-cell; by the activity of the nuclei simpler organs, such as the germinal layers, first appear; then come more developed structures, such as the enteric, nervous, and osseous systems; all these developments have one and the same molecular structure of the nuclei, modified in various types, and slightly variable in the individuals of a given type; but this is of such a kind that the idioplasm has essentially the same structure in every stage of development. But it is not to be supposed that the later organization is to be found in rudiment in the idioplasm of the fertilized egg-nucleus. All that is necessary to suppose is that typical regular movements take place in the nuclei, and that these are dependent on the structure of their idioplasm.

Let us suppose that in one case a fertilized egg-cell divides into quite equal parts n times, and in other $n + x$ times, we shall have two aggregates of cleavage-spheres varying in size. If, then, there are more nuclear divisions in thickness and breadth in one organism than in the other, we shall have fresh differences; and thus in every rudimentary organ a new type may arise by a special multiplication of nuclei in kind and number. Finally, we have histogenesis which is again referable to nuclei, where the idioplasm is for a long time the same in all the nuclei, but at last becomes quite lost in certain elements (blood-cells of mammals, integumentary scales, &c.).

Development and Significance of the Germinal Epithelium in the Testicle of the Chick.*—Prof. F. Laulanié comes to the conclusion that the elements of the testicle of the chick have no genetic relation to the germinal epithelium or to the Wolffian body; these elements arise in the stroma of the genital epithelium by a simultaneous differentiation; the germinal epithelium becomes the seat of an active proliferation, which has not hitherto been perceived; the nucleus of the cylindrical cells undergoes segmentation, the ovules divide, and at certain points penetrate into the sub-epithelial connective zone. These facts prove the tendency of the germinal epithelium to develope cortical ovules at the periphery of the testicle, while the seminiferous tubes are formed in its interior. Prof. Laulanié thinks that, the male elements having no common origin with the female elements, the double effort points to a morphological duality. This idea of the hermaphroditism of the testicle is supported by the fact that the evolution of the germinal epithelium is seen only in the left testicle; one law, therefore, regulates the development of this epithelium in the two sexes, and affords another argument in favour of an organic and primitive hermaphroditism.

Conditions of Tadpole Metamorphosis.†—Dr. D. Barfurth gives a detailed account of the series of experiments on tadpole development, as the result of which the following conclusions were established:—(1) low temperature retards metamorphosis, (2) quiet curtails it, (3) fasting also shortens it, (4) cutting off the tail is either without influence on the metamorphosis or retards it, (5) in the majority of cases *one* of the anterior extremities, usually the *right*, has the start of the other. In an appended paper he emphasizes the influence of hunger, or rather fasting, as a factor in development. In tadpole metamorphosis the extremities are completely developed some time before they are able to break through the covering skin. This liberation takes place as the skin becomes thinner and less firm. This is brought about by absorption of the elements of the cutis, which obviously takes place more rapidly in fasting animals, so that fasting

* Bull. Soc. Hist. Nat. Toulouse, xx. (1886) pp. 13–6.
† Arch. f. Mikr. Anat., xxix. (1887) pp. 1–34 (1 pl.).

is a factor influential in shortening the last stages of metamorphosis. With this other parallel phenomena are compared, and the author emphasizes the extent to which the economy of the organism is self-adjusting.

Absorption of the Tadpole's Tail.*— Dr. D. Barfurth has made a careful study of the exact manner in which the tadpole's tail gradually disappears. (1) The epidermis cells are simply atrophied, grow old, shrivel up, and die. (2) In the capillaries and smaller vessels the lumen disappears with disuse, and the elements on the walls fall off in small fragments to be eaten by leucocytes or dissolved. (3) The notochord and nerve-fibres seem to exhibit similar degeneration. The spinal cord cells become turbid and infiltrated with nuclear débris. (4) The muscle-fibres exhibit disruption into sarcolytes, fatty degeneration, and nuclear proliferation in the perimysium internum. (5) Leucocytes appear throughout devouring the débris, and carrying it to the lymph-vessels. (6) The material is used up for the development of more essential organs and tissues.

These degenerative processes begin only when the tissues are in process of death. The phagocytes appear, as Metschnikoff notes, when definite irritant elements or foreign bodies are present. The tissues begin to die in consequence of insufficient nutrition, and this in consequence of the cessation of trophic influence from the nervous system. The trophic influence ceases because the function of tail, after the appearance of the fore limbs, is superfluous. The weal of the entire organism finds expression through the central nervous system.

Intra-ovarian Egg in Osseous Fishes.†—Dr. R. Scharff has studied the intra-ovarian egg, chiefly in *Trigla gurnardus*.

In the youngest ova the nucleus occupies nearly the whole cell; the nucleoli being peripheral. Later, the surrounding protoplasm increased, and a darker internal portion can be distinguished, which arises from the nucleus. When the egg has almost reached its final size, the nucleus shrinks, and protuberances appear on all sides; these become constricted off and travel to the periphery of the egg. The author does not consider that the nucleus, although it degenerates, ever entirely disappears.

The most external membrane is the "zona radiata," within which a semi-fluid layer exists, which later disappears. A peculiar modification is noticed in the follicle cells of the egg of *Blennius photis*. As to the development of the ova, the author is inclined to think that only one cell is concerned. The egg-membranes do not appear till after the follicle.

Growth of Embryos of Osseous Fishes.‡—M. L. F. Henneguy finds that a series of longitudinal sections of the embryo of osseous fishes shows that, during the extension of the blastoderm on the vitellus, the embryo grows chiefly in the part comprised between Kupffer's vesicle and the protovertebræ; new somites are constantly formed in the anterior portion of this region. If this view be correct, it can hardly be brought into agreement with the theory of His, though it is compatible with the hypothesis of Kupffer and Oellacher. M. von Kowalewski, who has been studying recently the development of the ova of such Teleosteans as have ellipsoidal eggs, has been able to prove that, at the moment when the germinal layers are differentiated, the blastoderm grows along the whole of its periphery, but that the caudal extremity of the embryo remains fixed on a point of the vitellus. The author thinks it is very probable that the same is true of osseous fishes with spherical eggs.

* Arch. f. Mikr. Anat., xxix. (1887) pp. 35-60 (2 pls.).
† Proc. Roy. Soc., xli. (1886) pp. 447-9. ‡ Comptes Rendus, civ. (1886) pp. 85-7.

Development of Petromyzon fluviatilis.*—Mr. A. E. Shipley differs from Mr. Scott in his description of the formation of the mesoblast, for he finds that the ventral mesoblast is formed by the downgrowth of the mesoblastic plates, which ultimately meet and unite in the ventral middle line. Max Schultze was more correct than later observers in stating that the blastopore does not close up, but remains as the anus; there is no neurenteric canal. Anteriorly the hypoblast remains connected with the epiblast, and here the gill-clefts arise, the mesoblast growing down between them to form the gill-bars. The peculiarly constructed muscle-plates each arise from a single cell of the mesoblastic somites, the nucleus of which divides until each cell contains several nuclei; striated fibrils then appear to increase till the whole muscle-plate consists of little else; these "plates" arise from the segmental half of the mesoblast, while the muscles of the gills, lips, and probably of the eye, arise from the ventral unsegmented part and have a different structure. The blood-corpuscles arise from the ventral free edges of the mesoblast; the heart appears in the ventral mesentery, formed by the union of the lateral mesoblastic plates, and is at first continuous with a large sinus which lies just behind it. As this sinus acquires walls, it forms part of the subintestinal vein.

The ciliated funnels of the pronephros are left as apertures, owing to the closing up at intervals of the groove which forms the segmental duct. The canal of the central nervous system developes after the neural chord has separated off from the epidermis, and it does not appear to be lined by any invaginated epidermis. The first sign of cerebral differentiation is the formation on the sixteenth day of the optic vessels and pineal gland; the fore, mid, and hind brains appear a little later. The ganglia on the 5th, 7th, 9th, and 10th nerves are derived from epiblastic thickenings, and the ganglion of the fifth divides into two parts which have a common root. The origin of the ganglia on the cranial nerves has no relation to the sense-organs of the skin, which are not apparent in the oldest larvæ seen by the author.

The early development of the skeleton is described as far as the period at which began the researches of Prof. Parker.

Some Darwinistic Heresies.†—Prof. C. Vogt, while accepting all the fundamental points on which Darwinism is based, combats certain views which he regards as exaggerated or ill-founded. The idea with which we start, consciously or unconsciously, that nature sets before herself a purpose just as we do, is not just; he urges, for example, that, similar as all Equidæ are, they have a diphyletic origin. To deny this is to deny the facts of geological geography, and any phylogenetic tree which does not take it into account is by that fact alone erroneous or null. We must, then, conclude that there is a divergence of characters, and this is true of free-living as well as of parasitic organisms. Metamorphoses take place: (i.) By the reduction and final loss of primordial characters. (ii.) By the excessive and unilateral development of other characters which often originally existed only roughly sketched out. (iii.) By changes of function which imply the separation of parts originally united, and the fusion of other parts originally separated. If these statements are true there cannot be harmonious development in any organism, but only relative harmony, one or several organs being preponderant in development. Man himself, where everything is subordinated to the development of the brain, is a proof of this.

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 325–70 (4 pls.).

† Arch. Sci. Phys. et Nat., xvi. (1886) pp. 330–8; translated in Ann. and Mag. Nat. Hist., xix. (1886) pp. 57–61.

Further, the "fundamental biogenetic law" that the development of the individual is a compressed epitome of the history of the race, cannot be true; the contradictions which all embryologists recognize have been attempted to be explained as cenogenetic, or the results of falsified embryogeny. "Poor logic, how it is tortured! Nature falsifying herself!"

Phylogenetic speculations must, M. Vogt thinks, be completely reversed, and we must recognize that the less complicated animals owe their existence to a more or less complete retrogression, and that they must constitute the final terms and not the foundations of phylogenetic series. It is thought that such palæontological facts as the presence of Cephalopods and Dipnoids in the most ancient formations squares with the reformed hypothesis here enunciated.

β. Histology.*

Goblet-cells in Amphibian Bladder.†—Dr. J. H. List continuing his researches on goblet-cells, reports their presence in the epithelium of the bladder of Amphibia. The histology of the different layers is minutely described, and the form, size, and structure of the unicellular glands specially discussed. They arise in the deeper layers, undergo the usual modifications, and finally disappear after distinct secretion of their modified mucous contents. The details are corroboratory of List's previous researches.

Nerves of Electric Fishes.‡—Herr Fritsch is of opinion that the fibres of the axis-cylinder in the elements of the central nervous system of electric fishes arise from the fusion of protoplasmic processes. The axis-cylinder begins as a conical protrusion formed from the fusion of broad processes, and penetrated by vessels (*Gymnotus*, *Lophius piscatorius*, *Malopterurus electricus*. In the ganglion-cells (spinal ganglia) of *Lophius*, besides the axis-cylinder, fine processes pass through the wall and fuse outside. He thinks it not unjustifiable to conclude that fine processes of the nerve-cells may fuse to form the axis-cylinder, even when their fineness makes demonstration impossible.

γ. General. §

Marshall and Hurst's Practical Zoology.‖—Prof. A. Milnes Marshall and Mr. C. H. Hurst have published a 'Junior Course of Practical Zoology,' which ought to be very useful to all those who go beyond the work laid down in Huxley and Martin's well-known handbook. The forms dealt with are *Amœba*, *Paramecium aurelia*, *Vorticella*, *Hydra*, *Fasciola hepatica*, *Hirudo medicinalis*, *Lumbricus terrestris*, *Anodonta cygnea*, *Helix pomatia*, *Astacus fluviatilis*, *Periplaneta americana*, *Amphioxus lanceolatus*, *Scyllium canicula*, *Lepus cuniculus*, *Gallus bankiva*, and *Columba livia*. This list will show how widely the authors have thrown their net. Valuable explanations will be found here and there among the directions for dissection; there are forty-eight woodcuts, most of which are original and are among the best and most suggestive that a student, young or old, could have put before him. In an appendix a list of reagents is given, with their mode of preparation and the use to which they are to be put.

* This section is limited to papers relating to Cells and Fibres.

† Arch. f. Mikr. Anat., xxix. (1887) pp. 147–56 (1 pl.).

‡ Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1887) pp. 735–6.

§ This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

‖ A. Milnes Marshall and C. H. Hurst, 'A Junior Course of Practical Zoology,' 8vo, London, 1887, 440 pp. (48 figs.).

B. INVERTEBRATA.

Dotted Substance of Leydig.*—Dr. B. Haller has a note on the so-called Leydig's dotted substance in the central nervous system; the simplest condition of the central network of higher invertebrates is certainly to be found in some of the lower cephalophorous molluscs, such as the *Chitons;* in them the connective-tissue takes no part in the formation of the central plexus, which is exclusively formed of processes of ganglion-cells.

In the annelids *Lepidanthenia elegans* and *Nereis costæ*, the central non-ganglionated portion of the cerebrum consists of a nervous and connective plexus, which is traversed by commissural fibres and larger nerve-fibres; the inner fibres of the optic nerves arise from the central nervous plexus, while their outer fibres take their origin directly from the overlying larger ganglionic cells. The study of other groups leads the author to conclude that the central plexus is partly nervous and is partly formed by the processes of the ganglionic cells, and that this double mode of origin of the nerves is to be always found; as to the origin of this central nervous system it may be explained as being derived from that primitive system which covered the whole surface of the body.

Enterochlorophyll and Allied Pigments.†—Dr. C. A. MacMunn brings forward evidence decisive of the animal origin of enterochlorophyll, and of the presence of a true animal chlorophyll in *Spongilla;* in *Anthea cereus*, on the other hand, the chlorophyll is due to symbiotic algæ. The memoir contains also the author's observations on the saponifying of vegetable chlorophyll.

Myohæmatin and the Histohæmatins.‡—Dr. C. A. MacMunn adduces evidence in favour of the respiratory functions of these pigments, the discovery of which tends to confirm the theory that the formation of carbonic acid and the absorption of oxygen takes place in the tissues and not in the blood. Hæmatoporphyrin is identical with polyperythrin and is closely related to actinohæmatin.

Micro-organisms in Thermal Water.§—MM. A. Certes and Garrigou have been investigating the question whether there normally exist in thermal waters living organisms, and what part they play in the formation of that "glairine" and "barégine" which is found in sulphuretted waters. They conclude that in water taken at Luchon at a temperature of 64° C. there are rare very transparent mobile small rods, and more rarely immobile filaments, longer than the rods; in neither of these organisms were any granulations of reduced sulphur to be detected; no algæ, diatoms, or infusoria were to be seen, but the débris of vegetable or animal matter show that the waters are fertilized by atmospheric germs, and lead us to think they may be regarded as more or less successful culture fluids for such germs as can accommodate themselves to darkness, high temperature, and special chemical composition. When the water is not higher than 50° the masses of barégine appear; these are nothing more then zooglœæ of rods mixed with grains of reduced sulphur. Further experiments are necessary to determine the chemical and biological action of the rods, and this knowledge will throw a light on the therapeutics of mineral waters.

* Morphol. Jahrbuch, xii. (1886) pp. 325–32.
† Phil. Trans., clxxvii. (1886) pp. 235–66 (3 charts and 1 pl.).
‡ Op. cit., pp. 267–96 (1 chart and 1 pl.).
§ Comptes Rendus, ciii. (1886) pp. 703–6.

Fossil Calcareous Elements of Alcyonaria and Holothurioida.*—Herr P. Počta has found in the calcareous strata of Bohemia not only Foraminifera, Ostracoda, and calcareous spines and needles of unknown origin, but calcareous elements which appear to come from a new species of Alcyonarian which he calls *Nephthya cretacea*, and plates which closely resemble those of *Psolus phantapus*.

Mollusca.

Histology of the Mollusc Liver.†—In a long memoir Dr. J. Frenzel reports the result of his investigation of the histology of the mid-gut gland or liver of Mollusca. His researches include a considerable number of representative forms from all the sub-classes. After a full historical introduction the author passes to the discussion of,

1. *The histology of the glandular epithelium.* (*a*) *The granular cells.*—Granular cells, the liver-cells of Barfurth, occur in all molluscs except Cephalopods. They are most developed in the Opisthobranchiata. They contain, besides protoplasm and nucleus, a distinct spherical vesicular ball, inclosing more or less markedly pigmented granules, fat-globules of various size, and albumen-clumps in variable abundance. The pigmented granules are constant, the others may be absent especially in ripe cells. The fat varies with external conditions, and the same may be said of the occurrence of crystals. The size, shape, and contents of the cells are discussed in great detail, as also the results of various reagents. The presence of a hair-fringe is noted, which in Cephalopoda and some Lamellibranchs is long and in the latter occasionally mobile. From this the author maintains a ciliated fringe might be derived.

(*b*) *The club-shaped cells*, or ferment-cells of Barfurth, vary very greatly in form and contents. All the different forms are regarded by Frenzel as modifications. They seem to occur in all types of molluscs. As in the granular cells, they contain a secretion-ball, also with more or less pigmented contents, which are however fluid, or at most drop-like. Fat and albumen clumps, and in one case a crystal, are again present. The size, form, contents, changes, and reactions of the cells are noted at great length. The secretion occurs in fluid drop-like form, in clumps, or in firm spheres, The secretion of the granular cells withstands strong acids which dissolve that of the clubbed cells, but the difference is really only quantitative. Herr Frenzel comes to no definite conclusion as to the origin of the club-shaped cells.

(*c*) *The lime-cells.*—There is a frequent, but by no means general occurrence of cells with strongly refracting spheres of calcium phosphate. The following chapter of the memoir discusses the actual occurrence of these three elements in specific forms.

2. *The physiology of the liver.*—Dr. Frenzel regards it as demonstrated that the mid-gut gland of all molluscs has a digestive function, and that this function is discharged both by the granular and club-shaped cells, while the lime-cells are certainly not secretory. The pigmented contents form the principal portion of the digestive ferment. No proper bile contents could be demonstrated. Frenzel regards it as premature to ascribe to the organ any other function than that of secreting a digestive ferment, though the complex and variable histology may suggest something more. The memoir is accompanied with a gorgeous coloured plate.

* SB. K. Akad. Wiss. Wien, xcii. (1885) pp. 7-12 (1 pl.).
† Nova Acta Leop. Carol. Acad., xlviii. (1886) pp. 81-296 (3 pls.).

Early Development of Loligo.*—The segmentation of the egg and the formation of the germinal layers of *Loligo Pealii* are described by Mr. A. T. Bruce.

The protoplasm of the egg segregates to one pole, forming a germinal disc, which is segmented throughout its thickness. It then becomes split into two layers of cells, the ectoderm and mesoderm; but along a line, the future long axis of the embryo, the ectoderm alone is present, and in the region of this line certain cells separate from the mesoderm, which from the spindle shape and oval nuclei are recognized as endoderm cells. As no nuclei were observed in the yolk, no endoderm cells are derived therefrom spontaneously. The mesoderm bands become two cells thick; the endoderm spreads, and soon the ectoderm and endoderm surround the whole yolk, whilst the mesoderm extends only half-way round. A slight prominence in the centre of the embryonic area is the first trace of the mantle, and at this stage the two mesoderm bands were no longer separated.

'Challenger' Cephalopoda.†—Mr. W. E. Hoyle's report on the Cephalopoda collected by the 'Challenger' is almost completely systematic in scope; when careful attention was given to the characters of the radula, whence it was hoped assistance might be derived which would be important in the limitation of the species, it was found "that in almost every radula each row of teeth differs a little from the one preceding it, and very frequently five, six, or even more rows must be examined before a given form repeats itself; two rows of teeth from the same specimen will often differ as much as two from different species." From this it follows that the majority of figures hitherto published of Cephalopod radulæ are quite useless for diagnostic purposes.

A new family of Amphitretidæ is formed for *Amphitretus pelagicus*, which is unique among Cephalopods in having the mantle fused with the siphon in the median line, so that there are two openings into the branchial cavity, one on either side. *Japetella* is remarkable for its gelatinous semi-transparent body, but, unfortunately, like a number of other 'Challenger' specimens brought up by the trawl, there is considerable uncertainty as to its real place of origin. *Promachoteuthis* is provisionally defined, as only one specimen of a single species is as yet known. A special report on *Spirula* is being prepared by Professor Huxley; ten new types are added to the genus *Sepia*. From the stomach of a shark there were taken fragments of a gladius, which, if correctly referred to the genus *Chiroteuthis*, indicates that that genus must attain to dimensions hitherto unsuspected; what can be pieced together of this fragmentary pen amounts to 78 cm. *Histiopsis* is a new type, intermediate between *Calliteuthis* and *Histioteuthis*. The remarkable larva described by Ray Lankester as *Procalistes Suhmii* is referred to the genus *Taonius*.

Very few pelagic Cephalopods were obtained by the 'Challenger'; this may be explained by the enormous activity of these animals, which can only be captured when the vessel is going at great speed, or when, in other words, it is difficult or impossible to use a tow-net; the investigation of the contents of the digestive tracts of predaceous birds, fishes, and Cetacea, will probably do much to increase our knowledge of these molluscs. Apart from the fact that *Bathyteuthis* and *Mastigoteuthis* have slender filiform tentacles with minute suckers, no structural features have been discovered, which will serve to distinguish a deep-sea form from a shallow-water one.

* Johns-Hopkins Univ. Circulars, vi. (1886) pp. 45–6.

† Report of the Voyage of H.M.S. 'Challenger,' Monograph xliv., 4to, London, 1886, 245 pp. and 37 pls.

New Gymnosomatous Pteropod.*—M. P. Pelseneer recognizes four families of known gymnosomatous Pteropods—Pneumodermatidæ for *Pneumodermon*, *Dexiobranchæa*, and *Spongiobranchæa*; Clionidæ for *Clione*; Halopsychidæ for *Halopsyche*; and Clionopsidæ for *Clionopsis*. The new genus—*Notobranchæa*—which he now describes, must be placed in the fifth family of Notobranchæidæ; in it the body is contracted behind, and presents only a dorsal branchia, formed by three crests, of which the dorsal alone is fringed. Anterior and posterior lobes of the foot long and narrow, the former free in their posterior two-thirds. *N. MacDonaldii* sp. n. was taken off Carolina, and measures 8 mm. in length. M. Pelseneer considers that the Gymnosomata have been derived from the Aplysians, and that the least specialized genus is *Dexiobranchæa*, with lateral branchiæ; *Pneumodermon* is greatly complicated by the posterior branchia having four crests radiating from the original ring; *Clionopsis* shows retrogression, and *Clione* is apparently derived from *Notobranchæa*.

Embryology of Prosobranch Gasteropods.†—Dr. J. P. McMurrich adds some additional facts to his previous contributions ‡ on the subject.

He finds corrosive sublimate and alcohol the best fluids for preservation. Perenyi's fluid caused excessive swelling and distortion of the eggs containing much yolk.

He describes the egg-capsules of *Fulgur carica*, *Fasciolaria tulipa*, *Purpura floridana*, and a species of *Crepidula*.

1. *The ovum and nutrition of the embryo.*—Each capsule of *Fulgur* contains 12 or 14 large eggs, imbedded in a large quantity of albuminous substance, and containing much yolk. The reactions of the albumen showed it to be a proteid. In the case of *Fulgur*, all the eggs develope; but such is not the case in the other forms, where only a few out of numerous eggs develope, the rest serving as food. This breaking down is not due to non-fertilization, but to the quantity of yolk being too small for the number of eggs. He traces a series of stages in the proportional number of eggs which develope, and concludes that some change in environment has rendered it desirable for the eggs to remain longer in the capsule than their ancestors did. He gives a summary of observations on this head.

2. *Segmentation and formation of germinal layers.*—At the earliest stage the polar globule, which is single in *Fulgur*, was already formed, and contained yolk-granules. The ovum elongates, divides transversely into two equal parts, through the polar pole. A second division gives four equal spheres. Then, at the polar pole, an aggregation takes place from each of these, which gets nipped off to form four micromeres, which are completely protoplasmic. No further division takes place in the macromeres, which gradually fuse; but new micromeres arise partly from these, and partly from the micromeres. At a certain stage a peculiar elevation takes place in three of the macromeres, which is coincident with the first appearance of the mesoderm, in the fourth macromere. Ultimately epibole becomes complete, except for the blastopore.

Then follow several pages devoted to *theoretical* questions. From the presence of a single polar body in *Fulgur*, Dr. McMurrich considers that the relative amount of protoplasm and yolk influence the formation of these bodies, which may explain their usual absence in Crustacea. After a brief review of the various modes of segmentation in the invertebrate phyla, he

* Bull. Sci. Dep. Nord, ix. (1886) No. 6. Cf. Ann. and Mag. Nat. Hist., xix. (1886) pp. 79–80.

† Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1886) pp. 403–45 (4 pls.).

‡ See this Journal, 1886, p. 583.

suggests that the segmentation of Platyhelmintha, Annelida, Mollusca, and Molluscoida can be referred to a common type. It follows that the regular segmentation occurring in certain forms in each of these groups is brought about secondarily by loss of yolk originally present.

3. *The velum.*—This organ is developed from paired ectodermic folds on the ventral surface, which meet neither dorsally nor ventrally. The author finds in many Gastropods, that the velum consists of a preoral band of strong cilia, and a postoral band of smaller cilia; and between the two an area clothed with fine cilia, continuous with those of the œsophagus; this arrangement is probably characteristic of Prosobranchs.

4. *Excretory organs.*—In *Fulgur* there is no "head-kidney," but the larval kidney consists of ectoderm cells with highly refractive contents, as in *Nassa.*

Paludina and *Bithynia* alone amongst Prosobranchs possess a "head-kidney" as well as a larval kidney. The secreting cells were probably originally part of a preoral velar area, and as they became more important they separated from it and eventually replaced the "head-kidney."

5. *Nervous system and sense-organs.*—The cerebral and pedal ganglia are developed in the usual way from paired ectodermic thickenings. The latter have no connection with the "byssus-gland" or "aquiferous pore" as has been stated by some authors.

The typical apical thickening, as the origin of cerebral ganglia in the ancestor of Annelida and Mollusca, or "Trochozoon," is not present in Prosobranchs; it is present in Pulmonata, but the development of marine forms has been abbreviated and thus has been lost.

At the end of each chapter a summary and discussion of the results of previous writers is given.

Typical Nervous System of Prosobranchs.*—M. E. L. Bouvier finds that the nervous system of Prosobranchs is characterized by a chiastoneurous visceral commissure, or one twisted in the figure of 8. It has its origin in the commissural ganglia and contains a subintestinal branch which arises from the left commissural ganglion and passes backwards from left to right under the œsophagus; it forms a subintestinal ganglion, and trends towards the heart on the right side of the body; there is also a supra-intestinal branch which arises from the right commissural ganglion, and passes from right to left, forming a supra-intestinal ganglion; it makes its way along the left side of the body to join the subintestinal branch. This is the typical arrangement, but it becomes much more complicated in a number of forms. As to these the author sketches the characters of a few of the more important and significant.

Lepidomenia hystrix.†—MM. Marion and A. Kowalevsky give an account of a new genus of Solenogastres or amphineural molluscs, which was found at a depth of 30 metres in the Gulf of Marseilles; a single individual was found in the calyx of a *Balanophyllia italica*, and was scarcely 0·002 m. long. It is allied to *Proneomenia* by its internal organization, but is strongly distinguished by a very original spicular investment; the body is entirely covered with strong spines, the bases of which are applied directly to the hypodermis, without the interposition of any cuticular mass, such as is found in *Proneomenia.* When examined under low powers the surface seems to be covered not by spines, but by imbricated scales; this appearance is due to the bases of insertion of the spines which are more apparent than their hyaline mass. The hypodermis is relatively rather thick, and the most numerous of its elements are prismatic cells with large nuclei;

* Comptes Rendus, ciii. (1886) pp. 1274–6.

† Ibid., pp. 757–9.

scattered among these are large brown cells, which are probably glandular. In the posterior dorsal region the hypodermis is modified to form a small sensitive crypt, similar to that which is found in *Proneomenia*. The body-cavity is occupied by a fundamental connective tissue, similar to that which is found in various molluscs; below the pedal groove there is a larger sinus, and here the respiratory changes are effected by the currents set in motion by vibratile cilia; of the circulatory system, the heart alone is well differentiated; this is surrounded posteriorly by a large pericardium from which two simple nephridial tubes, surrounded by a secreting cellular mass, are given off. An anal cloaca is formed where these tubes unite in the region of the rectum. Though the animal was not sexually mature, it was clear that the generative apparatus was on the type of that of *Proneomenia*. There is a true radula with eight strong teeth, large salivary glands, and a small dorsal cæcum. The brain is large, and the lateral nerves immediately dilate into a small special ganglion; the two lateral bands are united by a transverse ganglionic commissure, and a strong commissure connects the two anterior pedal ganglia; no sublingual commissure could be made out.

'Challenger' Scaphopoda and Gastropoda.*—The Rev. A. B. Watson has a gigantic report on the Scaphopoda and Gastropoda collected by the 'Challenger'; there are in the collection about 1300 recognizable species, and some 400 indistinguishable forms. At 41 stations, whose depths range from 400 to 2650 fathoms, 89 old, 135 new species, and 46 indistinguishable forms were collected. On the whole, the collection is disappointing, but the methods of more recent dredging show that mechanical improvements may yet be introduced which will greatly extend our knowledge of deep-sea life. The author explains that the classification which he has adopted is not one of which he approves, but is the least objectionable he could find.

Mr. Watson remains of the opinion first expressed by him seven years ago, that there really are shallow and deep-water species and genera, though their bathymetric limits are not constant; temperature much more than depth is an important condition in molluscan life; great differences in depth and temperature form the barriers of distinct geographical provinces; but there are species whose distribution is universal. Though he does not desire to press negative evidence, Mr. Watson finds no trace, even in the oldest and most widely distributed species, of essential lasting and progressive change.

In an appendix the Marquis de Folin describes the Cœcidæ.

'Challenger' Marseniidæ.†—Dr. R. Bergh takes the opportunity given him by describing the few Marseniidæ collected by the 'Challenger' to write a valuable and compendious essay on the structure and characters of this family of Gastropods. A new genus, *Marseniopsis*, is described, which forms a remarkable link between the diclinous and the androgynous Marseniidæ, and prevents our splitting up the family. *M. pacifica* from Kerguelen and *M. Murrayi* from Marion Island, are the two new species of this interesting genus. The only other example of the family found by the 'Challenger' was *Marsenia dubia* sp. n.

'Challenger' Polyplacophora.‡—The report by Prof. H. C. Haddon on the few Chitons collected during the voyage of H.M.S. 'Challenger' deals

* Report of the Voyage of H.M.S. 'Challenger,' Monograph xlii., 4to, London, 1886, 756 pp., 3 pls.

† Report of the Voyage of H.M.S. 'Challenger,' Monograph xli., 4to, London, 1886, 24 pp. and 1 pl.

‡ Report of the Voyage of H.M.S. 'Challenger,' Monograph xliii. (1886) 56 pp. and 3 pls.

with the systematic aspect only, the anatomical report being deferred for the present. In his introductory remarks the author insists on the importance of distinguishing carefully local varieties, and recommends it as against indiscriminate formation of new species. About eighty specimens only were collected, which are referable to fifteen genera and thirty species, seven of which are here described for the first time.

Mouth-lobes of Lamellibranchs.*—Herr J. Thiele has examined the oral lobes in eighteen families of Lamellibranchs, and finds that in many cases they have so characteristic a structure as to be well adapted to be used, with other marks, as distinctive peculiarities.

They are invested in a single layer of ciliated epithelium, but the cells vary greatly in length; the long cilia pass through a distinct cuticular fringe. Beneath these there are goblet-cells. What appear to be sensory cells are to be found in depressions between the ridges, or on elevations of epithelium; they are always much scattered, and give off processes into the connective tissue. After describing the differences in these cells in various forms, the author commences his account of the connective tissue with a description of what obtains in *Mytilus*. Between the mucous cells are branched connective cells which contain "tubes" of intercellular substance; these are connected with a large blood-space which runs along the upper edge of the oral lobe, and is only shut off from the exterior by epithelium and connective-substance, the latter being not very compact; this blood-space may be regarded as a true vessel, it is probably arterial and corresponds to the tentacular artery of the Najades. Below the epithelium there is a structureless membrane which, on its inner side, contains considerable muscular and nervous bundles, generally arranged along the long axis of the oral lobe. The fibres which separately traverse the tissue are probably not to be regarded as muscles, but as connective-tissue cells, for the part which surrounds the nucleus often sends off irregular processes, and so marks them as spindle-cells. At the lower margin there are a quantity of cells which Flemming regards as small multicellular mucous glands; the author, however, has not been able to definitely make out efferent ducts. Along the line of fusion of the ridges with the tegumentary fold there are peculiar rods of modified connective substances, which in their relation to the staining reagents correspond to the so-called chitinous rods in the gills. After comparing other forms with *Mytilus*, the author resumes the results obtained by himself and other authors.

As to the physiology of these lobes, the first point to attempt to settle was the possibility of their having any function in relation to the ingestion of food. The arrangement of the cilia on the surface beset with ridges on the margin must produce a current which, when the oral lobes do not lie close to one another, must generally direct the firm particles to the margin. Direct experiment with Najades proved the importance of the oral lobes as directive organs. The use of the marginal currents appears to be to drive away the water from which the food has been obtained. The close relation to a large blood-vessel points also to a secondary respiratory function.

Further investigations are necessary before we can assure ourselves of the justice of Prof. Lovén's supposition that the labial tentacles of the adult Lamellibranch are the remains of the velum.

Morphology of Eye of Pectens.†—Prof. O. Bütschli directs attention to the hitherto unnoticed fact that in the eye of *Pecten jacobæus* the thin

* Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 239–72 (2 pls.).
† Festschrift Naturh.-Med. Ver. Heidelberg, 1886, pp. 175–80 (1 pl.).

peripheral margin of the layer of pigment-cells passes into the retina; the want of observation of this may be ascribed to the great delicacy of the cells in this region. Put generally, we find that the retina and pigment-layer form a closed optic vesicle, which, however, differs essentially from that of other molluscs in that the sensitive region is turned away from the light. This great difference appears to be easily explicable by the difference between the lenses of the two groups of molluscs. In molluscs other than *Pecten* the lens is a secretion-product formed in the interior of the optic vesicle, where it permanently or temporarily remains; in *Pecten*, and also in the Vertebrata, the cellular lens is formed outside the optic vesicle, and so the outer wall of the optic vesicle is turned towards it.

North Sea Mollusca.*—In the second part of the report on the Mollusca collected by the Norwegian North Sea Expedition Herr H. Friele describes the Pleurotomidæ, Cancellaria, and Brachiopoda; there were a number of species of *Bela*. *Asbjœrnsenia* is a new genus, which is placed before *Montacuta* and after *Philine*.

Molluscoida.

α. Tunicata.

The Salpa-chain.†—Mr. W. R. Brooks compares the development of the chain of *Salpa* to that of *Pyrosoma*.

He first describes briefly the development of the young *Pyrosoma*, and gives a detailed description of that of *Salpa*, the arrangement of the young *Salpæ* on the stolon, and the changes in position during growth. As in *Pyrosoma*, the young *Salpæ* are not produced by budding from the walls of the stolon, but arise by conversion of the segments of this structure into the bodies of the new organisms. But whereas in *Pyrosoma* there are only three or four young ones in successive stages of development, in *Salpa* there are many successive *sets*, each consisting of 50 to 100 individuals at the same stage. The stolon arises from the hæmal surface of the solitary *Salpa*, and consists of an outer wall of ectoderm and an inner endodermal tube, which communicates with the branchial sac of the parent, and arises from the floor of the ventral groove.

At first the young *Salpa*-chain is bilaterally symmetrical, but in the mature chain the individuals are placed in a rather complicated fashion, which arises from crowding and pressure. In reality there is a single series, each placed dorsum to venter, with the neural surface towards the base of the stolon, and the right sides of all on the right side of the stolon, so that the middle plane of symmetry coincides with the middle plane of the body of each *Salpa*.

By a rotation caused by crowding the complicated arrangement of the mature chain is brought about.

Mr. Brooks finds that horizontal sections are the only means of ascertaining the true relations, as each succcessive *Salpa* will be cut in a different plane.

The arrangement of the *Salpæ* to the stolon is given in detail.

Synascidians new to the French Coast.‡—M. A. Giard gives a notice of *Diazona hebridica* and *Distaplia rosea*, which appear to be new to the coast of France. M. Giard thinks that *Diazona* is a composite Clavelinid, and he points out that it approaches the simple Ascidians by the fact that

* Den Norske Nordhavs Expedition, 1876–8. xvi. Zoologi. Mollusca, ii. 4to., Christiania, 1886, 44 pp. and 5 pls. (Norwegian and English in parallel columns.)

† Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1886) pp. 451–73 (2 pls.).

‡ Comptes Rendus, ciii. (1886) pp. 755–7.

the ova are not incubated in the maternal organism, although he allows that this is by no means an essential character. The author does not agree with Della Valle in believing that there is any relationship between *Distaplia* and *Aplidium;* from a comparative study of the migratory buds and ova he comes to the conclusion that the former genus finds its closest allies in *Anchinia* and *Doliolum; Distaplia* is to *Anchinia* what the Diplosomidæ are to the Pyrosomatidæ—the fixed representatives of a pelagic form.

The free buds are true diblastulæ, comparable to the gemmiparous stolon of *Perophora*, which also arises at exactly the same anatomical point in each individual of the colony.

β. Polyzoa.

Metamorphosis of Bryozoa.*—M. J. Barrois thinks that in considering the metamorphosis of the Bryozoa we ought to distinguish two great types, one represented by *Phoronis* and one by *Pedicellina*. The former is characterized by the predominance of the ventral surface, which forms the whole of the body, and by the reduction of the dorsal surface to a terminal region; in the latter the aboral surface (or the cephalic end of the trochosphere) predominates, and extends above the whole oral (somatic) surface to form the whole of the integument of the adult, the somatic surface being pushed into the interior. He does not look upon what obtains in the Chilostomata as being really an intermediate condition; while not denying that the evagination of the internal sac of the larvæ of the Ectoprocta may be considered as the same thing as the evagination of the ventral tube of *Phoronis*, he notes that it does not play a determining part in the acquisition of the characters of the adult, and that it is not followed, as in *Phoronis* and *Rhabdopleura*, by the reduction of the whole of the aboral surface; this rather continues to form an umbrella.

Both types of development are derived from the trochosphere, the author withdrawing his previous comparison of Bryozoa to a rotifer fixed by its oral surface; that of most Bryozoa is due to the predominance of the cephalic and the indrawal of the somatic region; that of *Phoronis* (and perhaps also *Rhabdopleura*) to the predominance of the ventral face and the crowding of the whole of the dorsal surface (the preoral lobe and velum being here included) into a restricted portion of the terminal region. The Entoprocta are regarded as being the most primitive of the Bryozoa.

The conclusions of this memoir are based on the study of a number of different forms, amongst which are *Lepralia pallasiana*, *Bugula flabellata*, *Serialaria lendigera*, which is the most typical example of the tun-shaped larvæ, and *Pedicellina*. The theory of alternation of generation is altogether rejected.

New Family of Bryozoa.†—Dr. J. Jullien institutes the new family of *Costulidæ* for the *Cribrilina* of Gray; *Escharella arge* D'Orbigny may be regarded as the typical species; the seventeen recent and fossil genera of which it is composed are defined, and five new species (two new genera) are described.

Arthropoda.

Spermatogenesis of Arthropods.‡—Prof. G. Gilson has communicated a lengthy memoir in which some of his results on the spermatogenesis of Arthropods are set forth. After a careful review of the history and a dis-

* Ann. Sci. Nat., i. (1886) 194 pp. (4 pls.).
† Bull. Soc. Zool. France, xi. (1886) pp. 601–20 (4 pls.).
‡ La Cellule, i. pp. 1–188 (8 pls.). See this Journal, *ante*, p. 69.

cussion of the all too-abundant nomenclature, Gilson reports his observations on the development of sperms in certain Myriopods, Insects, Arachnids, and Crustaceans. In doing so the author observes the following order:—(1) The steps in the evolution of the mother-cells, that is to say, the series of cellular multiplications which end in a last generation of sperm cells which are directly transformed into sperms; (2) the formation of the spermatozoid, characterized by phenomena of internal differentiation occurring within the protoplasm and the nucleus of the sperm cell; (3) the special phenomena concerned with the liberation of the ripe sperms. *Primordial metrocytes* give rise to *metrocytes* or actual mother-cells (spermatogonia, &c., of authors), and these form *spermatic cells* (spermatocytes), which develop directly into sperms. Whether the spermatocytes appear as external buds on the metrocyte or by internal endogenous division there, they are throughout to be regarded as homologous. A more extended notice may be deferred till Gilson's further results on Crustaceans come to hand.

Nervous System of Insects and Spiders and Remarks on Phrynus.*—*Acridium* and *Thyridopteryx* served Mr. A. T. Bruce for his study of the nervous system in insects.

The supra-œsophageal ganglion of insects and Arachnids is distinctly double. Each ganglion of the ventral chain is closely invested by mesoblast cells forming a "perineurium," which originates as a median ingrowth along the ventral mid-line. The perineurium also invests the transverse and longitudinal commissures, and each of two adjacent ganglia. These latter are at first solid masses of cells, the central portion of which breaks down and becomes "punktsubstanz"; by extension laterally and longitudinally, this gives rise to the commissures.

The supra-œsophageal ganglion has exactly the same structure, and is divided into an anterior and posterior division, separated by perineurium. The "brain" therefore of insects and spiders consists of two pairs of ganglia serially homologous with the ganglia of the ventral chain. The anterior division belongs to the antennal somite, and innervates the antennæ of insects and the rostrum of spiders; both these are special homologues with the first antennæ of Crustacea.

The posterior division belongs to the somite of the upper lip, which is a paired structure in the two insects studied, so that the labrum of insects and spiders is homologous with the second antennæ of Crustacea.

The circum-œsophageal commissures in insects are formed by a backward extension of the posterior division of the ganglion, and the nerves coming off from it really belong to the ganglia.

Some observations were made on the embryos of *Phrynus;* the resemblance of the ventral surface of the adult to that of *Limulus* is noted. There is a curved process on the inner side of the coxal joint of the last thoracic appendage, corresponding to that of *Limulus.* Paired structures are present resembling the chilaria. Each of the three last appendages bear episterna.

On the coxal joint of fourth appendage there is a sense-organ; the epidermic cells are here columnar, and are continued outwards as filaments, several of which enter a single pair, which is the external part of the sense-organ.

Function of Palps of Myriopods and Spiders.†—M. F. Plateau finds that in the chilopodous Myriopoda, as in mandibulate insects, the palps are not indispensable for capturing prey, recognizing food, or introducing it

* Johns-Hopkins Univ. Circulars, vi. (1886) p. 47.
† Bull. Soc. Zool. France, xi. (1886) pp. 512–30.

into the buccal cavity. Unmutilated chilopods use their palps as a first pair of limbs to turn the prey in the directions most suitable to their being cut by the mandibles. The palps are also used to clean the joints of the antennæ, and sometimes of the feet.

In female spiders the palps do not seem to have any more importance than the reduced limbs, and specimens deprived of these organs, spin their threads quite normally, and take and suck insects in exactly the same manner as uninjured examples do.

If the author's conclusions are just, it would seem that the palps of mandibulate insects, female spiders, and Myriopods, are degenerate cephalic appendages which have lost their primitive size and function, and have become almost useless organs, of which their possessor may be deprived without suffering any inconvenience.

a. Insecta.

Vesicating Insects.*—M. H. Beauregard continues his researches on vesicating insects or Meloidæ, of which previous reports have been given. (1) *The circulatory and respiratory systems* are first briefly discussed, but do not differ in any important point from those of other insects. (2) The *nervous system* is also simply referred to, as Beauregard's results were essentially confirmatory of the careful investigations of Audouin, Brandt, Ratzburg, and Erichson. (3) The *reproductive system* of the male is then discussed in detail, with special reference to the common Cantharid (*Cantharis vesicatoria*). (*a*) The *testes* are almost spherical bodies, colourless or slightly yellow, composed of a large number of elongated tubules opening centrally into a common reservoir, with which the end of the vasa deferentia is associated. (*b*) The *vasa deferentia* consist of an epididymis portion, lined with large cylindrical cells and clad externally by a muscular tunic. This is followed by a larger cylindrical tube, which serves as a sperm reservoir. It opens into the enlarged urn-shaped anterior extremity of (*c*) the *ejaculatory duct*, which forms for the rest of its course a muscular tube. There are three pairs of (*d*) *accessory glands* which open into the swollen anterior urn of the ejaculatory duct. The insertion and structure of these glands is then described. Omitting the histological details, the first pair consist of scorpioid tubes with a mucous secreting function, and never acting as sperm-reservoirs. The short cæca which form the second pair also contain a sort of granular mucus. The third pair consist of long necklace-like tubes with very thin walls. They alone function as seminal reservoirs, and are at the same time the seat of the production of the active principle cantharidine. Nine different forms are then discussed. In most there are three accessory glands, but *Sitaris* has only two, and *Epicauta* four. Among those with three pairs, *Zonitis* and *Mylabrum* are somewhat divergent.

Biology of Chrysomelidæ.†—Herr Weise points out that much still remains to be done on the biology of the Chrysomelidæ; from the facts cited by him with regard to the habits of the larvæ, it is clear that the subject is one of much interest, and that there are considerable differences to be observed in various forms.

Anatomy and Physiology of Tongue of Bee.‡—Herr P. F. Breithaupt has chiefly investigated the tongue in species of *Bombus* where the parts

* Journ. Anat. et Physiol., xxii. (1886) pp. 524–48 (1 pl.).
† Naturforscher, xix. (1886) pp. 510–11.
‡ Arch. f. Naturgesch., cii. (1886) pp. 47–112 (2 pls.).

are much larger and less liable to variation than in *Apis mellifica;* for the former, he used as staining reagent acid carmine, but for the latter, borax carmine or hæmatoxylin. After a general account of the structure of the mouth-parts, the author proceeds to describe their finer anatomy.

The tongue is described as having a groove with its edges directed downwards, which extends as a closed canal along the whole length of the chitinous rod, and only posteriorly widens out into the lingual groove; the small-spoonlike process is nothing more than the continuation of the chitinous rod which projects over the lingual mantle; the outer membrane of the latter is highly chitinized and covered with the long anteriorly directed setæ, which were called by Wolff collecting hairs; these are 1/5 mm. long, terminate in a fine tip, and are inserted in regularly arranged whorls; these last form horny arches which support the walls of the tongue. The hairs are longest and strongest on the dorsal side of the tongue, and decrease in length and strength as they pass backwards; at the tip they form a branch which is very well adapted to take up the honey. The length of the whole tongue is, in workers of *Apis mellifica* about 6·5 mm., in drones and queens about one-half of that, the shortness, of course, being correlated with their mode of life; the tongue varies in breadth, and is longer behind than in front; in *Apis* it is from 0·045–0·085 mm. broad anteriorly, and 0·16–0·18 mm. posteriorly.

In the chapter on the mentum, the paraglossæ are described as scale-like structures which form the inner sheath of the tongue; on their upper surface they are very horny and beset with tactile hairs, while below they are formed of delicate membrane; the glands formed by the side of the tongue in *Bombus* are wanting in *Apis*, and this fact, together with the small size of the system, leads us to think that they have no important function; as no chemical investigation of their secretion was possible, it is not easy to say what that function is, but their position leads us to suppose that they must oil the neighbouring parts and diminish the friction of the chitinous organs.

From the few observations the author was able to make, he concludes that in bees the sense of smell and taste are not physiologically separated. The musculature and mechanism of the apparatus of the labium has been very closely investigated, and is carefully described; with regard to the suctorial act, the experiments which were made seem to show that there are two possible paths by which the honey may be taken up; one is by the great suctorial tube of the proboscis, when the bee only licks the sugar with its tongue, and the other is by the capillary tube of the chitinous rod which would take up the last remains of the sugar. The bee, then, only licks so long as there is sufficient fluid; when this begins to fail, and the honey can only be reached by the outermost tip of the tongue, the tube is put into use.

Wall-bee and its Parasites.*—Herr K. Lampert has studied the life-history and parasites of the wall-bee (*Chalicodoma muraria*). In the case of this solitary bee, there are, as is well-known, no special workers. The female builds the many-celled stony nest on the warm side of rough-hewn walls, stores it with honey, lays the eggs, and shuts them up. If the weather is good as many as 16 cells may be built. In northern countries there is only one annual brood. The larvæ pass into the pupa-stage in June and July, spin a glassy skin, and remain for a variable period quiescent. The young bee does not get out till spring, however, and some

* Jahreshefte d. Vereins f. Vaterl. Naturk. in Württ., 1886. Cf. Naturforscher, xx. (1887) pp. 15–6.

damping of their prison walls seems almost necessary before they can make their escape.

Before the eggs are shut in, however, some lurking parasites have utilized the nest for their brood also. From larval intruders found in the nest, Lampert reared no fewer than nine different parasites,—Hymenoptera, Coleoptera, and Diptera. The bee *Stelis nasuta* is one of the commonest of these thieves, and sometimes four larvæ were found in one cell. It is probable that these devour first the food and then the wall-bee larvæ for which it was intended. The wasp *Monodontomerus nitidus* is an equally common thief; sometimes 36 were found in one cell. Lampert thinks that the mother inserts the eggs through the wall of the nest. These were found sometimes within the cocoon of the wall-bee, sometimes within that of a Stelis intruder. Three Diptera pursue the same tactics e. g. *Argyromœba sinuata.* The most dangerous foes, however, are the Coleopterous *Trichodes alvearius* and *Tr. apiarius*, the larvæ of which sometimes bore from one cell to another; *Meloë erythrocnemus* was also found.

Scales of Lepidoptera.*—Herr E. Hase discusses peculiar scale structures in Lepidoptera. He notes first the tire-spur (Schienensporn), a secondary sexual character, aiding in the mutual attraction of the sexes. In the spur there lies a gland which appears to moisten the olfactory organ in the antennæ. The spur is absent in specially well-developed feelers in the male, and on the plump wingless females of Geometræ, and only occurs in both sexes of Heteroceræ when they are both capable of flight, and that at the same time of day. Special male scales occur, sometimes hidden and covered with a fragrant secretion, and apparently attractive. In the male of Ornithoptera, &c., a peculiar form of wing is associated with the presence of these scales. The fragrance is scattered by long mobile tufts of scale-hairs, or rubbed off by the so-called rubbing spots (Reibeflecke). Other hard scales on both sexes of the Indian genus *Hypsa* appear to produce a shrill sound, as otherwise occurs in the male of *Thecophore fovea* (Rogenhofer) and of the Indian *Caristes membranacea.*

Larva of Smerinthus and its Food-plants.†—Mr. E. B. Poulton details his new experiments on this subject undertaken in order to throw more light on the two questions raised in his previous paper,‡ viz.—(1) are larval tendencies towards certain colours transmitted? and (2) is it the colour, and not the substance, of the leaf eaten, that influences the colour of the larva? To both these questions his numerous experiments point to an answer in the affirmative.

The second question was tested by sewing together the edges of a folded leaf, so that only one surface, upper or lower, was exposed, and therefore eaten by the larva. The author gives details of his experiments with five batches of larvæ raised from eggs which had been laid by moths bred in captivity.

As to the occasional occurrence of yellow larvæ on leaves of *Salix viminalis*, various evidence points to the following explanation:—the larvæ are only affected by that part of the plant in close contact with them; the tint of mature larval life is a resultant of conflicting tints of various periods of larval life; the ultimate predominance of any tint being due to the relative proportion of larval life passed in such a tinted environment. The strong influence for white, which the apple leaf exerts, is due to the fact of the large size of the leaf, so that the larva even when large can still remain

* Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte Berlin, 1886. Cf. Biol. Centralbl., vi. (1886) p. 640, and Naturforscher, xix. (1886) p. 510.

† Proc. Roy. Soc., xl. (1886) pp. 135–73.

‡ See this Journal, 1886, p. 429.

on the leaf, and does not migrate to the stem till a later period than in the case of larvæ feeding on smaller leaves, such as *Salix*. The paper ends in a summary, in tabular form, of the evidence derived from the various experiments.

Tracheal Gills of Pupæ of Simulidæ.*—Dr. Vogler has had his attention directed to some pupæ which he found on various water-plants in the Rhine, which were remarkable for the trachea-like shining tubes which were developed at the anterior end of the body; in the more common species they were proportionately short and thick, and in the other very long and fine. The anterior end of the body of these pupæ is blunt, and forms an almost circular surface, the centre of which is occupied by the pronotum; in the space between it and the case there are two spindle-shaped gill-tubes, which are so bent as together to form a circle; at about the middle of one of these basal tubes there are given off six almost cylindrical and equally long tubes, while a true trachea provided with a distinct spiral opens below. A stigmatic ring connects the short process of the basal tube with the trachea; the latter is so distinct as to seem to lie outside the body; it then suddenly bends inwards, and passes to a tracheal limb of the body.

The apparatus consists, therefore, of two similar—right and left—halves, which are not in direct connection with one another; each half consists of blindly ending tubes which form a circularly closed cavity which is connected with the body-tracheæ by a short connecting tube. There is no essential difference between the form with short and that with long tubes.

The tubes are filled with air so long as they remain connected with the animal, but when the case is abandoned they become filled with water, and form a home for infusoria, &c. Each tube has a thin and apparently structureless chitinous investment, on which is a thin granular or dotted layer; but it is not certain whether the dots are the optical expression of pores.

Wings of Diptera.†—Dr. E. Adolph has systematized the descriptive terminology of the veins and folds in the wings of Diptera, and has endeavoured to trace the derivation of the manifold forms from a typical plan. His patient and elaborate work is illustrated by figures of about fifty different wings in which the concave and convex veins and folds are clearly represented by lines of different colour and construction. The memoir will doubtless be of service in facilitating the labours of specialists in this department of entomology.

Life-history of Aphides.‡—Dr. H. F. Kessler has followed the life-history of several species of Aphis, including especially *A. padi*, *A. euonymi*, *A. viburni*, *A. mali*, *A. pyri*, and *A. sambuci*. He has shown that the genus Aphis contains forms which exhibit essentially the same history as that demonstrated in some *Tetraneura*, *Schizoneura*, and *Pemphigus* species. At the end of spring, as Lichtenstein noted, they leave the plant which they originally infest, and return to it at the end of summer or in autumn. They survive the winter as ova, and begin their activity with the commencement of the vegetation in spring. The author questions the correctness of the supposition that the Aphides as such survive the winter, along with, or even without the presence of ova. In *Aphis padi* the following three phases in the cycle are distinguished:—(1) The spring phase on *Prunus padus*, including the ancestral form, with its immediate progeny,

* MT. Schweizer. Entomol. Gesell., vii. (1886) pp. 277–82.
† Nova Acta Leop.-Carol. Acad., xlvii. (1885) pp. 269–314 (4 pls.).
‡ Ibid., pp. 117–140 (1 pl.).

which are both winged and wingless, and their descendants, which are all equipped with wings; (2) the summer phase on some unknown plant, beginning with a wingless, and ending with a winged form; (3) the autumn phase again on *Prunus padus*, including the sexual forms and the egg from which the ancestor of next year's brood is developed in the following spring.

Orthezia cataphracta.*—Dr. J. H. List has prepared a monograph of the female of this Coccid, which is found leading a subterranean life in the Alps; it has generally an oval form, but varies considerably, and there is much difference between young and older examples. It is 3 mm. long, and 2·5 mm. broad, while the marsupium or egg-sack projects 1·5 to 2 mm. backwards. The external integument is wax-like; there is a dorsal carapace of varying form, the exact relations of which are fully detailed, and there is also a ventral carapace; the whole has, in living specimens, a white colour, and when magnified, is seen to be superficially striated, the striæ running symmetrically on the right and left halves; it is composed of a body closely resembling wax, and fuses at about 80° C., but in young individuals at 83° C. When this is removed by needles or dissolved off by chloroform, the internal chitinous integument becomes apparent; in it areas similar to those of the outer integument are to be detected; the outer is beset with setæ which may attain a length of about 19 μ, are hollow, open to the exterior, and formed of chitin; under each seta a canal leads to the internal surface of the carapace, and this widens out to a funnel internally; these canals serve to carry the wax-like mass that forms the outer integument. In addition to these setæ there are spine-setæ, which are also hollow organs, but are closed, and end by a sharp point; they are placed within small chitinous papillæ; they are in connection with a canal which leads through the integument. Other processes may be called chitinous papillæ, and they are best developed in the region of the marsupium. In the hypodermis unicellular glands are to be found, and these are specially abundant on the chitinous funnel of the anus. There are also in the hypodermis some larger cells, which are covered by the dorsal and ventral muscles; these are surrounded by a distinct membrane, and clearly go to form the adipose tissue.

The author gives a detailed account of the muscular system, and makes the following observations on the structure of the tissue. If a bundle is observed in 0·5 per cent. salt solution it is seen to have a fine longitudinal striation, and to be of a fibrillar character; the whole bundle is surrounded by the sarcolemma, which is swollen up at a number of points, where long oval nuclei are to be seen; between the fibrils there is sarcoplasm, in which nuclei are still to be made out. Sections of muscles hardened in alcohol or sublimate-picric acid allow us to study the composition of the part; by the action of the hardening material the bundles are somewhat separated from one another. Typical transversely striated muscular bundles are also to be found.

A thoracic may be distinguished from an abdominal tracheal plexus; in the former there are tracheal vesicles from each of which a primary trunk arises; the disposition of the secondary branches and of the transverse commissures is described in detail; the abdominal plexus has seven pairs of stigmatic orifices, but they are much smaller than the two thoracic stigmata. The whole system is completely open, or is on the holopneustic plan of Palmén.

The mouth-parts are described in detail, and it is striking to observe

* Zeitschr. f. Wiss. Zool., xlv. (1886) pp. 1–86 (6 pls.).

how different they are in *Orthezia cataphracta* from the same parts as described by Mr. E. L. Mark for *O. characias* Bosc (= *O. urticæ* L.). They are followed by a description of the digestive tract. With regard to the Malpighian vessels, the author commences at their point of insertion into the mid-gut; the common tube divides into two, and these two tubes again divide into two branches which extend from the third to the eleventh segment. Each pair forms a loop on either side, and the two unite in the middle line; all four vessels lie at first above the rectum. With regard to their finer structure, it is noted that there is externally a transparent homogeneous membrane in which no cell-nuclei can be detected; in each vessel there are two rows of cells, each of which in profile appears to be six-sided. The cells are surrounded by a distinct membrane, and contain bright spheres of various sizes; the nucleus appears after staining; it is spheroidal or ellipsoidal, and has a distinct membrane with a nucleolus which appears to the author to be an elongated thickening of the nuclear membrane. Transverse sections through a vessel reveal the presence of a central canal; the vessels are very richly supplied with tracheæ which are mostly provided by the abdominal plexus.

With regard to the manner in which the insect takes in its fluid food, the author states that he was unable to convince himself of the presence of any pumping apparatus, and he thinks that the fluid enters by capillary action due to the canals of the bundles of setæ. The arrangement and histology of the salivary glands are described.

The little-known nervous system of the Coccidæ reminds the author of the great resemblance between its ventral medulla and that of the Myzostomata; in the supra-œsophageal ganglion he was able to observe unipolar ganglion-cells, the largest of which were 17 μ long, and had a transverse diameter of 11 μ; two or three nuclei were to be seen in them, no distinct membrane was to be detected, and no suggestions can be made as to their function. The antennæ are remarkable for the variations in the number of their joints, and that even in one and the same individual, where the left antennæ may have eight, and the right seven joints; another individual had five or six joints.

In an elaborate description of the generative apparatus it is pointed out that from the yolk-spheres formed by the fusion of the epithelial cells there is developed, after the degeneration of the nuclei of the epithelial cells, a unicellular structure provided with a large nucleus—the mature yolk-cell.

β. Myriopoda.

Special Sensory Organs of Myriopods.*—Dr. E. Tömösváry describes a peculiar sense-organ which he has observed in species of *Lithobius*; it is found in front of the eyes at the lateral margin of the head, where it has the form of an infundibuliform depression, at the base of which there is a small round orifice. The inner surface is clothed with ganglion-cells connected with the optic nerve. In *Polyxenus lagurus* the organ lies on either side of the head, and has three round orifices with projecting edges; in each of these there is a proportionately very long hair, connected at its base with a ganglion; the hair is movable in various directions. A very different sense-organ is found in species of *Pauropus* at the ends of their feelers between the tentacles; this may be conical, or be surrounded by two movable semilunar plates; these organs are so small as to require high magnification for their detection. Special sense-organs are also to be detected in species of *Glomeris*; in *Scutigera* they are at the base of the

* Mathemat. u. Naturwiss. Berichte aus Ungarn, i. (1883) pp. 324–6.

inner part of the lower maxillary palp. These organs are probably useful in detecting variations in the conditions of the atmosphere.

Mechanism of Respiration in Myriopods.*—In the Myriopods there are no special movements in the respiratory apparatus, able to produce an indraught and outdraught of air, as in insects. M. J. Chalande has made experiments on some of the Myriopods, and comes to the conclusion that inspiration and expiration of air are due to contraction and expansion of the dorsal vessel. The blood passing along the sinuses in the body bathes the tracheæ, and accentuates at each contraction the curve of the tracheæ; thus there is an alternating increase and decrease of the total capacity of the respiratory apparatus, during repose. This is increased during motion by the action of the muscles of the legs, and by the movement of the alimentary tract during digestion. Moreover a lowering of the temperature acts on respiration by a diminution in the contractions of the dorsal vessel.

Structure of Spinning-glands of Geophilidæ.†—Dr. E. Tömösváry finds that the spinning-glands of *Geophilus* have the ordinary constitution of arthropod dermal glands—gland, duct, and tunica propria of the gland; each compound gland ordinarily opens by a special compound gland; and these are themselves found between the space formed by the lateral fold of the pleura and between the muscles of the last body-segment; they are spherical or pyriform in shape, and consist of a number of tubular simple glands of the value of cells; in each a cell-membrane, granular cell-contents, and a cell-nucleus are to be made out. The efferent duct is proportionately long and rather wide, and has a pretty thick hyaline wall; the tunica propria is a fine hyaline membrane which may be regarded as the inner membrane of the matrix of the chitinous layer. It may be concluded that the spinning-glands are compound dorsal glands which are derived from the ectoderm, and have undergone invagination. They are very like the poison-glands of Chilopods, but their spinning function is inferred from the fact that it is their fluid secretion—which hardens on exposure to air—that forms the body which cements together the ova and spermatozoa.

Phosphorescence of Geophilus.‡—M. Macé has studied the phosphorescence of a species which appears to be *Geophilus simplex;* the phenomenon seemed to him to be due to a colourless liquid which is very slightly viscous and dries rapidly; it is not excreted from the anal orifice, but from the whole of the ventral surface of the body; the light is a little less strong than that of *Lampyris* and seems to be of a green colour. At the commencement of the observation the whole of the back was phosphorescent, but at the sides were the two lines of greatest intensity; after a short time the light began to fade from the back, and then from the side; for some minutes a longitudinal row of bright dots shone at the sides. These, so far as the author could judge from the darkness in which the observations were necessarily carried on, were situated near the stigmatic orifices.

The explanation of Dubois does not seem to apply to these Myriopods; like certain *Chætopteri* and Polynoids described by Panceri, the light seems to be due to a mucus secreted by the skin, and transverse sections show that, in the region of the stigmata, there are masses of large hypodermic cells which are probably the secreting agents.

* Comptes Rendus, civ. (1887) pp. 126–7.
† Mathemat. u. Naturwiss. Berichte aus Ungarn, ii. (1884) pp. 441–6 (1 pl.).
‡ Comptes Rendus, ciii. (1886) pp. 1273–4.

Respiratory Organ of Scutigeridæ.* — Dr. E. Tömösváry describes the respiratory organ of the Scutigeridæ as being much flattened, about 1 mm. long and 1·5 mm. broad, with the form of two kidneys fused along their inner edge; the stigmatic orifice leads into a respiratory cavity, the upper and lower surface of which are formed by basal membrane, the respiratory tubes arising only from the anterior and lateral margins; these tracheæ are very fine and hyaline, and gradually but regularly narrow to their blind end; they never anastomose with one another along their course, they are quite homogeneous, and show no indication of spiral filaments. There is no peritoneal investment, such as is found in other Tracheata; or, if it is present, it is modified. The glandular appearance of the tubes, which has led some authors to ascribe a glandular function to these organs, is explained as being due to the presence of wandered cell-nuclei of the tracheal matrix, which are found between the tubes.

δ. Arachnida.

Non-nucleated Blastoderm-cells.†—Korottneff, Grassi, and others have described amœboid cells becoming blastoderm-cells, but at certain stages without nuclei. Herr W. Schimkiewitsch has noted the same phenomenon in the development of spider ova. Since he had traced the non-nucleated cells, however, from the division of the germinal vesicle and surrounding protoplasm, he, of course doubted the possibility of the nucleus being absent. He treated the sections, preserved in Kleinenberg's fluid, with a weak solution of ammonia, and stained them with borax-carmine, with the result that in the densely stained elements, rounded unstained corpuscles could be detected, *like empty nuclei*. This he compares with results of other observers, and suggests that the unstained bodies are true nuclei, from which the chromatic substance has been passed into the surrounding protoplasm. He regards it, then, as probable that all the so-called non-nucleated blastoderm-cells are simply instances of the temporary disappearance of the chromatin nuclear substance.

Embryology of Spiders.‡—Herr J. Morin communicates a brief notice of his researches on the embryology of spiders. His investigations were based upon Theridion, Pholcus, Drassus, and Lycosa, but refer especially to the first of these.

(*a*) After being laid, the ovum of Theridion exhibits two egg-envelopes, the chorion and the vitelline membrane. In the centre lies the germinal vesicle, surrounded by finely granular protoplasm giving off strands into the surrounding yolk. In two hours the nucleus divides into two, four, and eight segments, but the yolk remains still undivided. When the eight-cell stage is reached, however, the yolk also divides into eight pyramids, with a central segmentation-cavity. The segments multiply regularly and each contains a single nucleus. The nuclei move towards the surface, and when the number of segments is 128, the outer nucleated portions are separated from the internal yolk portions, which then flow together again.

(*b*) Soon afterwards the embryo is seen to consist of three kinds of cell, (1) the layer surrounding the whole (ectoderm), (2) a number of cells separated from the former and lying immediately beneath it on the ventral surface (mesoderm), and (3) several cells of similar origin which have penetrated into the yolk (endoderm). In Theridion there is no "primitive cumulus" such as is formed in Pholcus, Drassus, &c. This cumulus is an

* Mathemat. u. Naturwiss. Berichte aus Ungarn, i. (1883) pp. 175–80 (1 pl.).
† Arch. Slav. de Biol., ii. (1886) pp. 26–7.
‡ Biol. Centralbl., vi. (1887) pp. 658–63.

accumulation of mesoderm cells, which gradually separates from the main mass, and pushes the passive ectoderm outwards before it. The component cells become large and round and extend dorsally, eventually forming blood-corpuscles.

(*c*) The triangular germinal disc becomes distinctly marked. The apex or posterior lobe represents the rudiment of the abdomen, the base or anterior lobe that of the cephalothorax. Transverse furrows form the segments and the appendages appear as papilla-like protrusions of ectoderm, into which the mesoderm also penetrates. The mesoderm is also segmented, and the body-cavity appears as a cleft in each segment. Large round cells near the somites form the blood-corpuscles. The ganglia begin to appear as paired thickenings of ectoderm. Salensky's observation as to the two semicircular folds in the head-lobes is confirmed. Soon the halves of the germinal disc, and also the mesoderm somites begin to grow dorsally and eventually meet above. The incipient blood-corpuscles collect in a dorsal abdominal strand, and this is surrounded by mesoderm which thus forms the heart. The stomodæum and proctodæum are formed as usual. A few days before liberation, the scattered endoderm cells in the yolk separate themselves from the latter at the internal ends of stomodæum and proctodæum, forming two tubes which grow together. These come into association with the rudiments of the liver lobes. The respiratory sacs appear as two ectodermic invaginations at the base of the first pair of abdominal appendages, which become their external coverings. The second pair of abdominal appendages disappear. The third and fourth pair form the spinning papillæ as Salensky noted. Ectodermic invaginations form the glands. The Malpighian tubes develope from two evaginations from the proctodæum.

Anatomy and Physiology of Glyciphagidæ.*—M. P. Mégnin finds that the small cylindrical prolongation which has been described by MM. Fumouze and Robin at the end of the abdomen of the female *Glyciphagus* is an exclusively copulatory organ; before copulation it is a tube open to the exterior and communicating with a spherical pouch, which is a true spermatic reservoir; after the act the opening of the tube becomes obliterated, the pouch disappears, and the ova are laid by the subthoracic genital organ, which has no other function.

At times of starvation the young octopod *Glyciphagi* undergo a protoplasmic liquefaction of all the organs contained in the limbs and trunk; the gelatinous material is collected in the cavity of the thorax, and its spherical mass becomes surrounded by a chitinous envelope. So long as the circumstances persist, which led to this condition, so long it persists, and the creature is like a grain of dust at the mercy of the wind; put under, or reaching more suitable conditions, development proceeds. Here, we have the explanation of the sudden appearance of myriads of mites which seem to have appeared spontaneously.

Anatomy of the Tyroglyphidæ.†—Dr. A. Nalepa in his second essay on the anatomy of the Tyroglyphidæ, states that the chitinous covering is generally thin and extensile; where it is thicker it is friable and striated; the hypodermis is a plexus of ramified cells with rare nuclei, and the connective tissue has a similar structure. In the latter there is a quantity of fat and carbonate of lime deposited, and here and there are colossal fat-cells. The oil-glands are dermal organs, developed in shallow pits of the epiblast on either side of the proctodæum; they are invested in a cubical epithelium which secretes an oily fat.

* Comptes Rendus, ciii. (1886) pp. 1276–8.
† SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 116–67 (3 pls.).

The maxillæ, labrum, and labium fuse to form a buccal tube, and the chelicerae are innervated from the central ganglion; the stomach has two lateral cæca; there is no muscular tissue, and the œsophagus has no epithelium; there is a suctorial apparatus in the pharynx; two tubular Malpighian vessels open into the rectum and have a granular excretion rich in uric acid.

The male generative apparatus consists of two testes, two vasa deferentia. and accessory glands; the penis varies considerably in form, and offers a good means for distinguishing species; it consists of a groove, to which is articulated a plate perforated by the ductus ejaculatorius; its supporting plates are movably connected with the integument, and on either side are two suctorial pouches with two suckers each. The females have two ovaries with long ducts, a vagina, and a receptaculum seminis, which is connected with the ovaries by two short canals, and opens to the exterior by a retro-anal orifice. The spermatozoa are immobile rounded cells; the gonads are developed from two cell-aggregates placed on either side of the proctodæum, and of, apparently, epiblastic origin; the receptaculum is an invagination of the hypodermal tissue which lies behind the anus. In addition to the retractors of the suckers, there are others which move the lower supporting plate.

The central nervous system consists of a cerebral ganglion and a broad ventral ganglionic plate; the two are intimately connected, and there is only a narrow canal between them for the passage of the œsophagus; the ganglion sends off nerves to the cheliceræ and maxillary palps, and the plate innervates the maxillæ, feet, and abdomen; the ganglionic cells do not vary much in size; the nerves are finely striated.

At the first ecdysis, the fourth pair of feet are developed from the imaginal discs, which underlie the third pair of the six-legged larvæ; it is not correct to think that the organs of the larvæ liquefy before each ecdysis. *Trichodactylus* is sometimes ovoviviparous, and its ova are attached by a stalk, the oral ovarian pole being always directed upwards.

ε. Crustacea.

Embryology of Alpheus and other Crustacea, and the development of the Compound Eye.*—Mr. H. F. Herrick studied the development in *Alpheus*, *Hippia*, *Palæmonites*, and other decapod crustacea.

The origin of the ovarian egg in *Alpheus* and in *Palinurus* resembles that in the lobster. The fertile egg of *Alpheus minus* has a large segmentation nucleus, which early becomes an ill-defined mass of chromatin thread, and is imbedded in a central area of protoplasm, which forms the usual network inclosing the yolk-spherules.

After two or four parts have arisen by division, the chromatin of each part becomes concentrated at various points, giving rise to a swarm of small nuclei, each with a distinct cell-wall and granular contents. In the next stage observed, the yolks had undergone partial segmentation into pyramids.

In one species of *Alpheus* this pyramidal structure is partly lost; the superficial cells are widely separated, and lie slightly below the surface, and some are sunk in the yolk. They apparently form part of the endoderm. In the next stage a complete blastoderm is formed and a small invagination takes place; but the cells of the endoderm are not well-defined, they send processes into the yolk and at the bottom of the

* Johns-Hopkins Univ. Circulars, vi. (1886) pp. 42–4 (1 fig.).

archenteron, multiply and send into the yolk nuclei, from which new endoderm cells are formed.

The archenteron is obscured, and is never included within the yolk. There is a great accumulation of nuclei at the side of the blastopore, just below the blastoderm, and these become mesoderm cells, which also appear in the abdominal region later on. Thus, the mesoderm arises partly from the superficial and partly from the invaginated ectoderm.

After the appearance of the nauplius stage, the development passes on much in the same way as in the lobster. The development of the eye has been traced through all the later stages in *Alpheus* and *Palæmonites.*

At the nauplius stage the brain and optic ganglia form a continuous mass of ectoderm cells arising by proliferation of the superficial ectoderm. There is no invaginated cavity such as Kingsley has described. The optic ganglia nearly meet above the brain; the superficial ectoderm cells elongate, and from these cells alone the eye is formed. These divide transversely, so as to form a series of radial strings. Separating these from the underlying yolk, or, in some cases mesoderm, is a basal membrane which soon becomes pigmented. The pigment cells elongate radially outwards, and become the retinulæ, and each ommatidium of *Alpheus*, *Penæus*, and the other decapods examined, possesses *seven* retinulæ.

The outermost cells of the strings separate slightly from the inner ones, and form the corneal hypodermis which secretes the cornea. Below these follows a stratum of more elongated cells, the retinophoræ; these are in groups of four, with white granular matter between each; this is a secretion product, which will form the crystalline cones. The space between the cornea and retinophoræ is filled by undifferentiated ectoderm cells. Between and around the retinulæ, a chitinous framework becomes developed, which is continued below the basal membrane.

The primitive ommatidium does not resemble an ocellus; nor does the development of the compound eye favour the supposition that it has arisen by a gradual fusion of ocelli.

Sense of Touch in Astacus.*—Mr. G. L. Gulland describes his experiments and the results derived therefrom, as to the structure and distribution of the setæ on *Astacus*. These setæ are either *sensory*, in which case the lumen communicates with the canal through the integument at the end of which the seta is articulated; or they are simply *fringing setæ*, when this lumen is closed, and no nerve can be traced into it. Of the sensory setæ—auditory, olfactory, or tactile—he discusses only the last, which are most conveniently seen in the abdominal swimmerets. They are long, simple, cylindrical at the base and hollow, with granules in the lumen—the remains of a "papilla" of the hypodermis, which assist, after a moult, in the formation of a new seta. In the fringing setæ, the lumen is closed near the proximal end by a chitinous ingrowth but in *Thysanopoda* this closure is absent. A detailed account is given of the distribution of the tactile setæ on the appendages and body of *Astacus*.

The nerve-endings were studied in the great chela. They are nearly cylindrical, surrounded by a membrane, in direct continuity with the surrounding connective tissue. Within the membrane is granular protoplasm, in which are a number of nuclei resembling those of ganglion-cells. At the proximal end of this tactile organ the nerve-fibres break up and become continuous with its protoplasm. There are generally two or three nerve-end organs to each tuft of setæ. Each nerve-fibre, after leaving the end-organ, passes through the hypodermis, and breaks up, sending a branch into each

* Proc. R. Phys. Soc. Edin., cxv. (1885–6) pp. 151–79 (2 pls.).

seta, but does not pass up the whole length of the lumen. There is a glandular structure amongst the nerve-endings of the great claw, which resembles a salivary gland. As to the ganglion in the claw, it is not a reflex centre, but is probably sensory, collecting the impressions from the end-organs, and transmitting them to the central nervous system.

The author traces out a genealogy of the setæ. Starting with a primitive seta, allied to a fringing seta, but not so flattened, it stood over a wide canal; the lumen was not closed; there was a single row of bristles on each side, and a nerve-ending attached to its base. From this seta the fringing setæ were derived in one direction, and the sensory setæ along another line; these were at first primary tactile setæ, which became modified in three directions, to give rise to auditory, olfactory, and tactile setæ.

Embryology of Schizopods.*—Herr J. Nusbaum gives a preliminary sketch of the early stages in the development of *Mysis Chameleo*. Before segmentation begins the egg exhibits a large quantity of nutritive yolk, and at the formative pole an aggregation of finely granular protoplasm with a large round nucleus. A thin layer of homogeneous protoplasm extends over the whole surface of the yolk. The nucleus divides and the peripheral half multiplies into the nuclei of blastoderm disc, while the other remains under the egg-membrane. In the middle of the disc there are some large cells dividing tangentially. Some of the other cells divide radially, and an accumulation of cells is gradually formed beneath the blastoderm. These Nusbaum calls "vitellophagous," because they subsequently absorb the yolk-material into which they penetrate.

The margins of the blastoderm gradually grow round the yolk. The thickened disc consists of cylindrical and cubical cells, and lies on the ventral surface of the posterior part of the ovum. As it widens, an unpaired caudal portion, two lateral ventral strands, and the anterior head-lobes gradually become differentiated.

At the posterior caudal disc a shallow invagination is formed, and the cells of the floor of the invaginated portion multiply rapidly and form a solid mass of endoderm cells. The mesoderm appears as two solid strands of cells, arising from the ectoderm, and lying along the thickened ventral strands above referred to. They multiply rapidly and grow inwards. At the time when the rudimentary limbs are appearing the mesoderm strands exhibit three corresponding thickenings. Somatic and splanchnic layers are afterwards differentiated. The origin of the germinal layers is compared with that of insects, &c. The endoderm forms the paired rudiment of the liver, and a portion of the midgut. On each side of the ventral strand, two symmetrical, disc-like ectodermic thickenings appear at an early stage. They form two oval sacs, lined by long pyramidal cells, and containing a homogeneous substance. They represent the saddle-shaped organs of *Oniscus*, *Ligia oceanica*, and the dorsal organ of *Asellus* and *Orchestia*.

'Challenger' Stomatopoda.†—Prof. W. K. Brooks thinks that the primitive stomatopod was characterized by the possession of small, subcylindrical eyes, an acutely pointed rostrum, a smooth hind-body, a short wide smooth carapace, very small antennary scales and uropods, and a telson which was wider than long. This primitive form is represented to-day by *Protosquilla*, from which the various genera have diverged. Most near to it stand *Gonodactylus*, *Pseudosquilla*, and *Coronida;* the last leads to *Lysiosquilla* and *Squilla*.

* Biol. Centralbl., vi. (1887) pp. 663–7.

† Report of the Voyage of H.M.S. 'Challenger,' Monograph xlv., 4to, London, 1886, 116 pp. and 16 pls.

In the study of this group very special attention must be given to the larvæ; the larval life is so long and forms such a considerable part of the total life of each individual, while the larvæ are so perfectly developed, and their relations to their environment so complex, that there are about as many species of larva as of adults, and the specific differences between them are fully as pronounced; the differences between different genera of larvæ are often greater than those between the genera of adults. The fully-grown larvæ are in no sense embryonic and generalized; save for the absence of reproductive organs they are just as highly organized as the mature forms. Using the special names which have been applied to them, Prof. Brooks makes a classificatory table of the larvæ which "exactly matches the one given for the adult Stomatopoda."

Of the fifteen species of adults collected by the 'Challenger' eight are new; the genus *Gonodactylus* is broken up into *Gonodactylus* (s. str.), *Protosquilla*, and *Coronida* gg. nn. Among the material there is sufficient for a full history of the *Alima*-larva; this is one of the largest of known pelagic larvæ, and leads an active life, pursuing and capturing with the greatest rapacity the Copepods and other small Crustacea which form the chief part of its food; Mr. Faxon has reared a *Squilla* from an *Alima*, and it appears that all Squillæ have *Alima*-larvæ. The author thinks that it can be shown conclusively that the *Alima* is an *Erichthus* which has become accelerated in development; the larva of the most primitive of the true *Squillæ* was probably an *Erichthus*-like *Alima*. If this view be correct the larvæ of all other genera of Stomatopods must be looked for among the Erichthi and Squillerichthi; here the series of larvæ are so complete and transitional forms are so numerous that it is very difficult to divide it into minor groups. The larva of the new genus *Coronida* appears to be very primitive and synthetic; for it the provisional name of *Erichthalmia synthetica* is proposed. All the larvæ found by the 'Challenger' are described in detail.

Isopoda of the 'Lightning,' 'Porcupine,' and 'Valorous' Expeditions.*—The Revs. A. M. Norman and T. R. R. Stebbing have published the first part of their report on the Isopoda of these British expeditions, in which they treat of the Apseudidæ, Tanaidæ, and Anthuridæ. Apart from the Serolidæ the most interesting of the abyssal Isopoda are the Munnidæ and Munniopsidæ, which are furnished with antennæ and legs of extraordinary length and delicacy of structure; unfortunately the free use of sieves in washing the ooze entirely mutilated such specimens as were collected by these British expeditions. In the present report G. O. Sars' arrangement of tribes and families is adopted.

Of the Apseudidæ *Sphyrapus* is a new genus, in which the animal is less elongated than its allies, there is no scale to the lower antennæ, and the peræon-segment unites with the carapace. Under the Tanaidæ reference is made to the interesting changes which are to be observed as following on moults, and a consideration of Mr. Faxon's observations leads to the suggestion that the enormous grasping-organs which so encroach on the mouth-organs as to deprive *Leptochelia* and *Anceus* of taking food, and which appear after the moult which precedes sexual intercourse, are moulted off after the discharge of the sexual functions; if they are not, their possessor must die of starvation. *Alaotanais* and *Tanaella* are new genera; the latter appear to be most closely allied to *Strongylura*, and the former has a marsupial pouch composed of eight lamellæ, which are attached to the first four free segments of the body.

* Trans. Zool. Soc. Lond., xii. (1886) pp. 77–141 (12 pls.).

Of the Anthuridæ there are four new genera—*Cyathura, Anthelura, Hyssura*, and *Calathura*.

In a postscript reference is made to works published since 1884; with regard to the species which forms the basis of Prof. Claus's memoir—*Apseudes latreillii*—the authors point out that it is certainly not that species as ordinarily understood, and they propose for it the name of *A. hastifrons;* two very important papers have also been published by Prof. Sars.

Diagnostic tables accompany the descriptions of the families and genera.

New Isopoda.*—Mr. C. Bovallius, in two essays on new or imperfectly known Isopoda, describes eight new species from various localities; with these, as with the previously named species which he re-describes, he gives, when he can, descriptions of males, ovigerous and virgin females and larvæ.

Asellidæ.†—Mr. C. Bovallius, in his notes on the Asellidæ, institutes three new generic names with the object of getting more uniformity in the system; these are *Iamna, Iathrippa*, and *Iais.* A useful analytical table of the genera is given. *Iais haryeii* is the only species; the old ones are carefully described and their synonymy fully given.

Amphipods.‡—Dr. H. Blanc has described seventeen Amphipod forms found in the Bay of Kiel. The memoir also contains a histological description of the calceoli or peculiarly shaped sensory organs found on the antennæ of many Amphipods. These were regarded by Sars, Leydig, and others as olfactory organs, but the author is apparently inclined to attribute to them an auditory function. The olfactory rods generally distributed on the anterior antennæ are also discussed.

Amphipoda Synopidea.§—Mr. C. Bovallius institutes a new tribe of Amphipoda Synopidea, for the forms intermediate between the Gammaridæ and the Hyperiidea; it is divisible into the three families of the Synopidæ, which are most closely related to the Gammarids, the Trischizostomatidæ, and the Hyperiopsidæ. The constituent species, among which are two new forms of *Synopia*, are very carefully described.

Forgotten Genera of Amphipoda.‖—Mr. C. Bovallius has some notes on *Lanceola* Say, which is not, as has been supposed, identical with *Hyperia* or *Vibilia;* of this rare form five new species are now described; on *Daira* Milne-Edwards, which is not identical with *Dairinia* of Dana, who changed the name in consequence of *Daira* being preoccupied, but it is apparently identical with *Paraphronima* of Claus; *Clydonia* Dana is identical with *Tyro* M.-E., and as the latter name has priority it must be restored; five new species are described. The distinctive characters of the genus *Tauria* Dana are pointed out.

Apus and Branchipus.¶—Herr Fickert points out as the result of his observations that *Branchipus* may be found alone, but *Apus* only where the former is also present. *Branchipus* is in fact the principal prey of *Apus*. Kept together for a night in conditions where escape is impossible, the weaker fall victims to the stronger. The nimble and transparent character

* Bihang Svenska Vet. Akad. Handlingar, x. (1885) 32 pp. and 5 pls.; xi. (1886) 19 pp. and 2 pls.

† Bihang Svenska Vet. Akad. Handlingar, xi. (1886) 54 pp.

‡ Nova Acta Leop.-Carol Acad., xlvii. (1885) pp. 37–104 (5 pls.).

§ Nova Acta R. Soc. Upsal., iii. (1886) 36 pp. and 3 pls.

‖ Bihang Svenska Vet. Akad. Handlingar, x. (1885) 18 pp. (1 pl.).

¶ Naturforscher, xx. (1887) pp. 5–6.

of *Branchipus* enable it, however, to survive in the open water in spite of its formidable enemy.

New Genus of Parasitic Copepoda.* —M. E. Cann has found in the tissue of the Synascidian *Morchellium argus*, a new genus of parasitic Copepods, for which he proposes the name of *Aplostoma brevicauda;* it is most remarkable on account of the reduction of the buccal armature, the mandibles, maxillæ, and first pair of maxillipeds being lost; the second pair of maxillipeds seems to be represented by two triarticulate appendages, but even these have acquired a locomotor function; the adult female is $1\frac{1}{2}$ mm. long, and the body consists of nine rings, four of which go to the short tail. Among the ascidiicolous forms the new genus seems to be most nearly allied to *Cryptopodus flavus*, but that species, as described by M. Hesse, has simple multiarticulate limbs, and two pairs of buccal appendages; in the considerable reduction of its abdominal region and the modification of the appendages of the fifth thoracic somite of the female, it approaches *Enterocola*, but it cannot be placed with either of these two generic types.

The Podostomata.†—Prof. A. S. Packard proposes the term Podostomata for the group formed by the orders Merostomata (with the suborders Xiphosura, Synxiphosura and Eurypterida) and Trilobita; they may be defined as marine arthropods in which the cephalic (*Limulus*) or cephalothoracic (Trilobites) appendages are in the form of legs, which usually end in chelæ, and have the basal joints spiny so as to aid in the retention and partial mastication of the food. No functional antennæ. Eyes both simple and compound. Respiration branchial. Brain supplying nerves to the eye alone, the nerves to the cephalic or cephalothoracic appendages originating from an œsophageal ring and the ventral cord ensheathed by a ventral arterial system. Highly developed coxal glands with no external opening in the adult.

The class differs from the Arachnida in having no functional chelicerræ ("mandibles") or pedipalps ("maxillæ") in the cephalic appendages, but bearing a minute pair of ungues, and in the absence of urinary tubes. They differ from the Crustacea in the lack of functional antennæ, in the mouth-parts, in the compound eyes having no rods or cover, in the distribution of the cerebral nerves, and in the possession of an arterial coat enveloping the central nervous cord.

Crustacea of the Norwegian North Sea Expedition.‡—In the second part of his report on the North Sea Crustacea Prof. G. O. Sars enumerates the 337 species collected, and discusses their geographical distribution; there are notes on a few; sixty-four in all are new, and of these thirty-eight are Amphipods.

Vermes.

α. Annelida.

Structure and Development of the Generative Organs of Earthworms.§—Dr. R. S. Bergh deals with the much-vexed question of the structure and development of the generative organs of earthworms; in his historical introduction he refers to the now well-known discovery of Hering, but he omits to notice that a description and figure of the generative

* Comptes Rendus, ciii. (1886) pp. 1025–7.
† Amer. Natural., xx. (1886) pp. 1060–6.
‡ Den Norske Nordhavs-Expedition, 1876–8, xv. Zoologi, Crustacea ii., 4to, Christiania, 1886, 96 pp., 1 map. (Norwegian and English in parallel columns.)
§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 303–32 (1 pl.).

parts of the earthworm consonant with Hering's account was in 1870 given by the late Prof. Rolleston in his 'Forms of Animal Life'—that is, ten years before Blomfield (not Bloomfield) and fifteen years before Vejdovsky. As Dr. Bergh finds much to correct or add to in the work of previous observers it will be necessary to give a detailed account of the present paper.

In all the species of *Lumbrici* examined by him there are normally two pairs of testes in the ninth and tenth and a pair of ovaries in the twelfth segment; the testes vary in form in different species; the organs taken by Vaillant, Perrier, and Beddard for the testes of *Perichæta* are the vesiculæ seminales; the two pairs of white spheres noticed, but not correctly understood, by Horst are really the testes. The ovaries appear to be sufficiently well known.

The ovaries and testes are parenchymatous organs, consisting of a thin cortex of peritoneum and an internal compact mass of germinal cells; Dr. Bergh has been able to detect a line of demarcation between cœlomic epithelial cells of the ordinary kind and those which build up the substance of the testes; the differences are most apparent in the nuclei, for those of the germinal mass are much clearer, larger, and rounded, while they stain less easily, and are not homogeneous, but have a very distinct plexiform protoplasmic framework. Much the same account applies to the histological characters of the ovary. The gonads are the sole part of the generative apparatus that are laid down during the life within the cocoon.

With regard to the nomenclature of what may be indifferently called the seminal reservoirs, the author suggests that the paired appendages shall be called the seminal vesicles, and the median unpaired part the seminal capsule. The simplest condition is found in *Lumbricus turgidus*, *fœtidus*, and three other species which Eisen unites under the name of *Allolobophora;* in these the median capsule is completely wanting, and the seminal infundibula are quite uncovered and freely lie in the cœlom. In these species there are four seminal vesicles on either side—each testicular segment having two pairs. In *Lumbricus* (s. str.), e.g. *L. terrestris*, the second of the four vesicles is wanting from either side, the anterior testicular segment has two pairs of outgrowths, and the hinder only one, while there is a median seminal capsule; this last is due to a fine horizontal membrane which divides each of the segmental cavities into a larger upper and a smaller lower division, and the cavity of the capsule is therefore a part of the cœlom which has been cut off. The vesicles and capsule form reservoirs in which the spermatozoa mature, but it is not yet known how the cells which break off from the testes make their way into them.

Blomfield has correctly stated that the vesicles are finely camerate organs, and in this they differ from the capsule, the cavity of which is quite simple. With regard to the same author's acceptation of Prof. Lankester's suggestion that the seminal vesicles arise as pocket-like outgrowths of the side walls of the rosettes of the seminal infundibula, Dr. Bergh somewhat strongly says "die Figur giebt nur die Lankester'sche Phantasie, aber keineswegs die Natur wieder." Dr. Bergh has had no difficulty in assuring himself that the seminal vesicles arise quite independently of the seminal infundibula; by the study of suitable sections, he has seen that the vesicles arise from thickenings and invagination of septa 8–9, 9–10, and 10–11; the outer epithelium and the groundwork of connective tissue arise from the peritoneum of one side of the septa; the peritoneum of the other side invaginates and forms the canal with its enlargement, while from the fundamental membrane of the septa the muscular fibres and the vessels grow into the vesicle. Though he has not been able to follow

the history of the median capsule, he is certain that the vesicles arise earlier than and independently of it.

The receptacula ovorum correspond in function and mode of development to the reservoirs; they are not simple vesicles, but are camerated; they arise independently of the oviducal infundibula.

The efferent genital ducts are next described and discussed, and there does not seem to be one fact to oppose the theory of their general homology with nephridia; the seminal pouches appear to be tegumentary glands modified for a special function, and to have absolutely nothing to do with segmental organs.

Anatomy and Histology of Branchiobdella varians.*—The object of Dr. W. Voigt is to add some histological details to Dorner's well-known memoir on this worm. With a view to determine the chemical characters of the cuticle, observations were made on various worms, and it was found that the cuticular substance of worms gives a different result after treatment with caustic potash to that which obtains with the chitin of Arthropods; and it must not yet be definitely stated that the cuticle of worms contains chitin. The cuticle of *Branchiobdella* consists of thin fibres crossing one another at right angles; there are macropores, but no micropores in it, and the former serve as the orifices of unicellular dermal glands; these pores are much smaller than those of the earthworm. The results of experiments on the contractility of the fibres explain the thinness and frequent loss of the cuticle in such forms as *Hirudo*, for here the extraordinary contractility of the body-wall acts on the system of fibres and produces considerable tension.

The hypodermis and circular musculature of *Branchiobdella* are intimately fused, and in the body-segments separated by an intermediate space from the longitudinal musculature; the hypodermis consists of simple cells set against one another like those of epithelium, and of unicellular glands, the contents of which are cleared up by the addition of dilute acetic acid. Below the hypodermis there is a membrane formed of the two lamellæ, which is the cause of the peculiar grouping of the glands between the circular muscles and of the so-called fenestrated appearance of the dermo-muscular tube. Some slight corrections are made in Dorner's account of the unicellular glands; in the seventh and eighth segments the nerves supplying the glands were observed to swell up at their ends into a ganglion from which nerve-ramules were sent to the several groups of glands.

The circular muscles are separated from one another by about their own diameter; no difference in their number could be detected by the author between the two varieties of the species, *parasita* and *hexodonta;* the longitudinal muscle is only slightly broken up into separate muscular bands; each muscle-cell is the length of a segment. In addition to those already described by Dorner there are two systems of smaller muscles, one of which runs parallel to the longitudinal muscles in each segment, and so serves to curve it on the contraction of the animal; the other lies beneath the longitudinal musculature, and, as it takes a diagonal direction, acts in the screw-like bendings of the body. The muscles are surrounded by a delicate sarcolemma and an envelope of connective tissue.

Dorner failed to note that blood circulates round the intestine, a blood-sinus surrounding the tube from end to end; in the dorsal and in the ventral middle lines this widens out to a distinct vascular trunk. In young forms the blood is corpuscular, but in the adult it is often yellowish or reddish, and there are no free cellular elements in it.

* Arb. Zool.-Zoot. Inst. Würzburg, viii. (1886) pp. 102–28 (1 pl.).

The whole of the digestive tract is, from the second segment to the anus, clothed internally by a simple epithelial layer, and this is certainly ciliated; below it is a nucleated membrane, which serves as a tunica propria, and also forms the inner wall of the blood-sinus; externally to this is a similar membrane, and the two are connected by rare filaments of connective tissue. Outside the muscular layer in some segments of the body there are the chloragogue cells, which are attached by a few processes to the outer wall of the blood-sinus, an arrangement which has not been observed in other Annulates.

Priapulidæ from Cape Horn.*—M. J. de Guerne reports that fourteen Priapulids were obtained by the mission to Cape Horn; of these, one is doubtful, two belong to *Priapulus tuberculatospinosus* obtained by Sir J. Ross, and the remainder to a new species—*Priapuloides australis;* it is much like the northern form *P. typicus*, but is distinguished by its smoother proboscis, and the larger development of its branchial appendages. The author gives a short account of its structural characters, and points out that it affords an interesting example of the presence in south-polar regions of forms which are almost identical with northern species.

β. Nemathelminthes.

Strongylus arnfieldi and S. tetracanthus.†—Dr. T. S. Cobbold describes the morphology of the hood and its rays of *Strongylus arnfieldi*, as well as the position of the vulva, and the structure of the embryo, contrasting them with those of allied forms.

The author's observations on the four-spined *Strongylus* show:—(1) The eggs are expelled from the parent in a state of fine yolk-cleavage. (2) The embryos are formed after egg-expulsion, and in a few days escape from their envelopes, undergoing a primary change of skin in the moist earth during warm weather. (3) Thereafter they live many weeks as rhabditiform nematoids. (4) In all likelihood an intermediary host is unnecessary. (5) The rhabditiform larvæ are passively transferred to their equine bearer either with fresh-cut fodder or whilst the animals are grazing. (6) Transferred to the intestinal canal they enter the walls of the cæcum and colon, encyst themselves, and undergo change of skin. (7) Their presence in the intestinal walls is associated with certain pathological conditions, frequently fatal to the bearer. (8) Ordinarily the young worms perforate their cysts and immigrate to the lumen of the intestine; indications of sex appear at this the Trichonema-stage. (9) They next form cocoons by the agglutination of vegetable débris within the intestine, and undergo a third ecdysis with intestinal metamorphosis. (10) The formation of the internal sexual organs and the completion of the definite form is accomplished within the colon of the host.

New Nematoid.‡—Prof. R. Leuckart states that during the larval stage of *Cecidomyia pini*, a nematoid worm, which calls to mind *Sphærularia*, is to be found in its cœlom; the name of *Asconema gibbosum* may be given to this new form. In addition to the peculiarities of the generative apparatus, the enteric tract, which has neither mouth nor anus, is remarkable for not forming a tube, but a solid cord formed of large cells rich in granules, which calls to mind the so-called cell-body of *Mermis albicans;* the ends of the cord are attached to the body-wall; the rudiment of a pharynx can be

* Comptes Rendus, ciii. (1886) pp. 760–2.
† Journ. Linn. Soc. Lond. (Zool.), xix. (1886) pp. 284–93 (1 pl.).
‡ Zool. Anzeig., ix. (1886) pp. 744–6; and Ber. Verhandl. Sächs. Gesell. Leipzig, 1886 (1887) pp. 356–65.

made out. Sexual reproduction is of course effected externally to the Cecidomyiæ, and after it the males die down, while the females, if they have the opportunity, make their way into the Cecidomyiæ larvæ, where they undergo a further change—they grow and the cells of their vagina increase in size to such an extent that they project from the genital orifice. As they continue to grow they press on the enteron, which they cause to lose its primitive structure, and to take on the cord-like disposition already described.

Helminthocecidiæ.*—Dr. F. Löw commences with the description of six new species of these gall-making Nematoids, two of which should be of especial interest to botanists, as they are the first galls which have been described in mosses. The second portion of the memoir deals with advances in our knowledge of species already described.

γ. Platyhelminthes.

Helminthological Observations.†—Dr. O. v. Linstow, in another communication with this now familiar title, gives an account of his investigations into the life-history of *Angiostomum nigrovenosum*. The ova of the hermaphrodite form found in the lungs of *Rana fusca*, contain the completely developed embryo; these have the integument very thin, are 0·13 mm. long and 0·6 mm. broad; on the eggs passing into the water they escape and grow rapidly; on the fourth day mature males begin to be observed, and on the eleventh, embryos were seen in the females, where a pair are found in a cuticular tube, although, just as in *Angiostomum entomelas* and *A. macrostomum*, there were primitively eight to ten eggs. The history of development and the embryos themselves are exactly the same in the three species.

After some notes on *Oxysoma brevicaudatum*, *Oxyuris ovocostata* sp. n. is described from the rectum of the larva of *Cetonia aurata; Distomum validum* is a new species 17 mm. long, from the stomach of an unstated species of dolphin; in connection with it a useful *résumé* is given of our knowledge of the dermomuscular tubes of the Trematoda; in this new species the subcuticula and the layer in which the circular and longitudinal muscles run is of an elastic-fibrous nature; this appears to be wanting in *Distoma* with delicate bodies, and to be limited to large species with proportionately stout cortical layers and well-developed muscles.

The rare *Distomum spiculator*, from the stomach of *Mus decumanus*, was very correctly described by Dujardin, to whose account Dr. von Linstow makes some additions.

Cysticercus tæniæ uncinatæ is a new cysticercus from the cœlom of the coleopterous *Silpha lævigata*, which agrees in its mode of development with *Urocystis prolifer;* but it is to be noted that the author objects to the formation of new and various genera of *Cysticercus*, as all are but stages in the development of *Tænia*. Dr. von Linstow repeats the essential parts of his discovery of the intermediate host of *Ascaris lumbricoides*, to which we have already drawn attention.‡

Distomum ingens.§—Prof. R. Moniez describes a new species of *Distomum*, and has some remarks on the comparative anatomy and histology of Trematodes. The new species is appropriately called *ingens*, as it is 6 cm. long, 2 cm. wide, and 1·5 cm. thick in its hinder region; the ova

* Verhandl. Zool.-Bot. Gesell. Wien, 1885, pp. 471-6. See Bot. Centralbl., xxviii. (1886) pp. 107-8.
† Arch. f. Naturgesch., lii. (1886) pp. 113-38 (4 pls.).
‡ See this Journal, 1886, p. 989.
§ Bull. Soc. Zool. France, xi. (1886) pp. 531-43 (1 pl.).

measure 38 by 23 μ. There is no indication of the origin of this remarkable form, which appears to be most closely allied to *D. personatum*.

Some of the results of M. Poirier as to the histology of the nervous system are traversed, the connective lamellæ which were said to embrace it not being apparent to M. Moniez; a careful description of the course of the nerves is given; some of the ganglion-cells are stated to attain the size of 50 by 30 μ; it is suggested that in some Trematodes we have a primitive arrangement of the nervous system. The parenchyma is regarded as being formed of a connective tissue with more or less close bars, the liquid which fills the interspaces coagulating under the influence of reagents; it is this coagulated matter which has given rise to the false interpretation of cells filled with protoplasm and touching one another; the justice of this criticism may be seen by a careful study of sections of the common fluke.

Nervous System of Tape-worms.*—As the results of his investigation of the central nervous system of *Tæniæ*, Herr G. Joseph notes—(1) that the two cerebral ganglia are in many cases (*T. transversalis*, *T. rophalocera*, hare) connected, not by a single dorsal commissure, but by two, separated by matrix and muscle-processes; (2) that each cerebral ganglion is triple, consisting of a median and two smaller (dorsal and ventral) ganglia, separated by muscle processes, as is best seen in *T. crassicollis*; (3) that in the bladder-worm, before the evagination of the hooks, the central system exhibits six equatorial ganglionic masses, which afterwards form a nerve-ring by the growth of bipolar processes.

Syndesmis.†—M. P. François makes some corrections in the account given by Mr. Silliman in 1881 of *Syndesmis*, a new Turbellarian; it is not ectoparasitic, but is found in abundance in the intestine of *Strongylocentrotus lividus*; the cilia of the epidermic cells are of the same size on the dorsal and ventral surfaces, and not larger below; the muscular system is formed by a system of well-developed dorsoventral fibres, and a few poorly developed longitudinal muscles in the anterior ventral region. There is no body-cavity; the digestive apparatus is more complex than has been supposed, but there are not a large number of testes, but only a pair, though these are provided with cæcal appendages; the uterus contains not one egg, but an ovoid shell which contains from two to thirteen eggs. The author corrects various errors as to the details of the female generative apparatus, into which he thinks that Mr. Silliman has fallen, but he agrees with his predecessor in the view that *Syndesmis* represents an intermediate form between the Trematoda and the Turbellaria. On account of its habitat he proposes to call it *S. echinorum*.

δ. Incertæ Sedis.

Studies on Rotatoria.‡—Dr. C. Zelinka describes two new species of the genus *Callidina*, *C. symbiotica* and *C. leitgebii*, which are found living on *Radula complanata*, *Frullania dilatata*, and other Hepaticæ; they are not true parasites, but "free space-parasites," dependent with the moss for rain and dew; they are widely distributed through Germany and Austria. Their anterior end is suddenly retracted and slowly extended, their movement is leech-like, and swimming is only rarely to be observed. Sixteen longitudinal folds are to be found on the back and sides, but are absent from the ventral surface. The matrix of the cuticle is a syncytial hypodermis.

* Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1887) p. 733.
† Comptes Rendus, ciii. (1886) pp. 752–4.
‡ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 396–506 (4 pls.).

The musculature is divided into a dermomuscular tube and muscles of the body-cavity; the former consists of a wide-meshed plexus of band-like longitudinal and circular muscles, which exhibit a division into primitive fibrils and posterior pieces; the longitudinal muscles are branched. The muscles of the body-cavity have their origin in the skin, and are either inserted into the segments of the body or into internal parts; they consist of contractile fibre-cells with homogeneous cortex and plasmatic axis, and they act more energetically than the dermal muscles. The cilia of the wheel-organ are separated on each hemisphere by a circular groove; in the lower circlet there are cilia which are directed towards the mouth. The buccal cavity is infundibuliform, and passes into a laterally compressed œsophagus. The wheel-organ is withdrawn by three homogeneous muscular fibres. From a study of this organ it is clear that, for a cilium to produce its effect the return must be slower than the blow or beating movement; the buccal cavity is able to divide into two cavities, the dorsal of which effects the indrawing, and the ventral, the removal of the corpuscles suspended in the water.

The terminal portion of the proboscis is beset with active cilia which are protected by two hyaline membranes; it contains a ganglion which is connected with the cerebrum by two strong nerves, and supports sensory cells surrounded by supporting cells. These last are processes of the hypodermis, which is itself connected with the hypodermis of the wheel-organ by a broad plasmatic band; the hypodermis is thickened above the ganglion.

The foot does not contain any of the organs specially belonging to the trunk, such as the enteric or excretory organs, but is in direct connection with the cœlom. The glands in it consist of four rows of uninuclear gland-cells, and an unpaired piece to which the rows are attached. The pharynx consists of two jaws with the proper musculature, and an elastic membrane which bounds the apparatus anteriorly; the dental formula is $\frac{2}{3}$. Two dorsal uninuclear and three ventral multinuclear salivary glands surround the pharynx; the œsophagus has a dorsal gland, and the stomach or chyle-intestine three pancreatic glands, which consist of a thick syncytial tube with numerous cell-nuclei, and a richly ciliated cuticle towards the lumen. It is attached to the dorsal integument by connective-tissue fibres, and is closed at its end by a muscular sphincter; the rectum has great powers of enlargement.

The central portion of the nervous system is an elongated pyriform cerebrum, the dotted substance of which lies in the centre surrounded by closely appressed nerve-cells; the peripheral nerves are sharply distinguished into groups for the anterior end and for the trunk. At the base of the tentacles and at the origin of the tentacular nerves there are several rounded cells; two nerve-fibres are stretched between the bases of the tentacle and the ganglion of the proboscis. There are two pairs of trunk-nerves, and these are finely granular.

The excretory organ consists of the contractile bladder, the ducts, and the ciliated lobes; in front of the opening into the bladder the tubes are constricted, and this arrangement prevents the return of fluid on the contraction of the bladder.

Males were never observed; the female generative organs are yolk-glands provided with highly granular and very bright large nuclei, which appear to be separated from the smaller germarium by a membrane; the ovum, consequently, appears to be nourished by a process of diosmosis. The whole organ is surrounded by a nucleated membrane; in the ripe condition the vitellarium and germarium form a syncytium, but in the un-

developed state the yolk-gland is formed of distinct cells; ordinarily only one egg is developed, and one gonad is ripe before the other.

Tornaria and Balanoglossus.*—Mr. G. B. Haldeman describes a Tornaria occurring on the Atlantic coast of America. It resembles that described by Metschnikoff, in being opaque, having eye-spots, and having the pore of the water-vessel on the left side.

The transformation of this larva was traced out, and the young *Balanoglossus* is only one-half the size of the Tornaria. It appears probable that it is the young of *B. Brooksii*. The author considers the homology between the water-vessels in this larva and in Bipinnaria to be true, and as justifying Metschnikoff's view of the relationship between the Enteropneusta and Echinodermata. But whether Tornaria or Bateson's larva (*B. kowalevskii*) is to be considered as more nearly representing an ancestral type, there is still the possibility that each may possess certain phylogenetic characters that have become obsolete in the other.

Echinodermata.

Holothurioidea of the 'Blake' Expeditions.†—Dr. H. Theél gives an account of the Holothurians dredged in the Gulf of Mexico, in the Caribbean Sea, and along the eastern coasts of the United States; the author wishes it to be regarded as an appendix to his recently issued 'Challenger' report; he describes several new species, but no new genera, and makes no general remarks.

Development of Generative Apparatus of Echinids.‡—M. H. Prouho reports that young individuals of *Strongylocentrotus lividus*, measuring 1 to 1·5 mm., have no genital pores or apparatus; the madreporic plate is pierced by two or three aquiferous pores and the sand-canal is well developed. Along this canal and supported by the same mesenteric layer there is an elongated cellular mass, which is the rudiment of the ovoid gland. In individuals of 3 mm. diameter, the genital plates are still imperforate, but the genital apparatus has begun to be formed. Delicate sections made parallel to the axis of the test reveal the existence, near the apical extremity of the growing ovoid gland, of a bud limited by a very distinct membrane. This bud, which will give rise to the whole genital apparatus, contains large nuclei. As the young urchin grows the bud developes, advances under the madreporite, and then prolonging itself under the other genital plates, makes the tour of the periproct. Opposite each interradius the ring thus formed gives off a prolongation in which the large nuclei, characteristic of the primitive bud, are always found. This is the condition of things in examples 6 mm. in size, and the genital apparatus may now be said to consist of five interradial buds connected with one another, and with the mesentery which supports the ovoid gland by a membranous circumanal ring. In individuals a little older, the five buds may be seen to give off small lateral ramifications, while their aboral end approaches and soon perforates the proper genital plate.

If this bud is given off from the ovoid gland the development of the genital apparatus of Echinids is effected by a process analogous to that described by Prof. Perrier in the Comatulidæ; it might be said that the growing gland is, or contains, a genital stolon like the dorsal organ of young Comatulids; but the author does not take this view. It is true that the

* Johns-Hopkins Univ. Circulars, vi. (1886) pp. 44–5.
† Bull. Mus. Comp. Zool. Cambridge, xiii. (1886) pp. 1–22 (1 pl.).
‡ Comptes Rendus, civ. (1887) pp. 83–5.

genital bud of the young urchin is enveloped by a membrane which is continuous with that which envelopes the ovoid organ, but it seems to be always separated from it—it can only be said that the primitive genital bud appears as a simple dependent of the mesenteric plate which surrounds the ovoid gland and the aquiferous tube.

Distribution of Sea-Urchins.*—Dr. W. Haacke communicates some interesting notes on the habits and distribution of sea-urchins considered in relation to their past history.

(1) In the first place he notes the characteristics and occurrence of two litoral Australian species, *Amblypneustes ovum* and *A. formosum*, which occur among the sea-grass and tangle banks. The former is found exclusively among the sea-grass; its colour corresponds to the greenish-yellow light of such a habitat, and its form is well adapted to its habit of climbing up and down on the sea-weed.

(2) Haacke emphasizes the necessity of caution and criticism in regard to what is often said in regard to the persistence of fossil forms in the great depths. The phylogenetically older regular sea-urchins are better represented, as Neumayr has shown, near the coast than in the deep sea. Uniformity of external conditions does not necessarily imply an unchanged persistence of ancestral environment, admitting of the persistence of primitive forms.

(3) Deep-sea fossils of previous epochs are unknown to us, and deep-sea forms must be compared with deep-sea forms. The preservation of litoral forms is very scanty, the conditions were not favourable, and the dead sea-urchins buoyed up by the gases of putrescence would then, as now, float away, and be broken up on the shore. The fossil remains both of the litoral and the upper continental areas are so scanty that a comparison of living and extinct forms becomes very hazardous. In the lower continental zone the preservation of fossil remains is more complete, and the recent extension of our knowledge of living forms has naturally led to the discovery of "living fossils." "The partial persistence of external conditions characteristic of earlier epochs has indeed favoured the survival of ancient forms, and such a persistence is not to be found exclusively in the deepest depths of the ocean, but for terrestrial animals on land, for fresh-water animals in their medium, for litoral animals near the shore, for 'continental' animals in their own zone, and only for true deep-sea forms in the abyssal region. A consideration of variations in habitat, mode of life, and forms must be associated with phylogenetic investigation. When this is done there will be no more marvel that the exploration of the deep sea has not revealed more 'living fossils.' It is younger than the shallow water, and in virtue of its peculiarity has allowed many of the old forms (which wandered into it from the latter) to die out, while others it has greatly modified."

Formation of Genital Organs and Appendages of the Ovoid Gland in Asterids.†—M. L. Cuénot thinks that it is impossible to interpret the vascular system of Asterids without having recourse to the development of the genital organs. In a young star-fish in which the gonad has not begun to be formed there is on the aboral and internal surface of the test a dorsal blood-vascular ring, which, at each interradius, gives off two cæcal vessels which are directed towards the extremity of the arm. In one interradius this ring communicates with the large sinus which incloses the ovoid gland and the sand-canal. At this time the gland is ovoid, but a little later it is prolonged into two buds which go to the right and left; these extend

* Biol. Centralbl., vi. (1887) pp. 641–7.
† Comptes Rendus, civ. (1887) pp. 88–90.

round the aboral circle, and in each interradius give off two branches which pass to the interior of the cæcal vessels belonging to two contiguous arms. Within the aboral circle and its genital vessels there is therefore a central cellular cord; this swells at the end of the vessel and becomes considerably developed, forming the genital organ which is completely surrounded by a sinus; the cells of the cord give rise to ova or spermatoblasts. An invagination of the integument now comes to meet the genital organ, which it finally puts into communication with the exterior.

This cord is directly derived from, and has the same structure as the ovoid gland; the ovum is morphologically the homologue of the blood-corpuscles, and the ovarian cells which do not become ova altogether resemble blood-corpuscles; a similar development does not take place in the testis.

The ovoid gland gives rise to yet another structure which appears before the genital organs; this is a glandular process which perforates the interradial sinus near its aboral extremity, and extends freely into the general cavity. *Luidia ciliaris* has one, *Asterias rubens* and others two, and *A. glacialis* three; they are totally wanting in *Cribrella* and *Echinaster;* Hoffmann and Ludwig have regarded them as intestinal vascular plexuses, and Jourdain as an excretory gland, but the author looks on them as belonging to the same group of lymphatic glands as the bodies of Tiedemann and the Polian vesicles.

Twelve-armed Comatula.*—Mr. A. Dendy gives a description of a female specimen of *Antedon rosacea*, in which one of the arms of each side bifurcates, giving twelve arms; with the mouth as anterior and anus as posterior, the third right arm and the fourth left arm are the abnormal ones. The second brachial of each of these resembles in shape the third radial plate, and carries on each side a third brachial, which is the starting-point for the new arm. Each of the two third brachials has a syzygy upon it. The two extra arms are supplied with ambulacral grooves, and the author suggests that it is due to these extra means of obtaining food that the specimen is of such a large size.

Morphology of Antedon rosacea.†—Dr. P. H. Carpenter calls attention to that portion of MM. Vogt and Yung's 'Traité d'Anatomie pratique' which deals with *Antedon rosacea;* he points out a number of errors of omission and commission which might have been saved by an acquaintance with what has already been published on the subject by writers other than Prof. Perrier.

Supposed Symbiotic Algæ in Antedon rosacea.‡—Dr. P. H. Carpenter criticizes the theory of Messrs. Vogt and Yung that the sacculi of *Antedon* are zooxanthellæ, and urges arguments against this view; attention is also drawn to the errors made by Perrier in the introduction to his new memoir on *Antedon.*

Cœlenterata.

Function of Nettle-cells.§—Dr. R. von Lendenfeld suggests that there can be but one explanation of the mode of action of, at any rate, the larger kind of nettle-cells or cnidoblasts; its structureless peduncle is a support, and may contract so as, under certain circumstances, to withdraw the cnidoblast from the surface; control over their movements is probably effected by

* Proc. R. Phys. Soc. Edin., cxv. (1885–6) pp. 180–3 (1 pl.).
† Ann. and Mag. Nat. Hist., xix. (1887) pp. 19–41.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 379–91 (1 fig.).
§ Ibid., pp. 393–9 (1 fig.).

means of the subepithelial nervous layer; the granular peduncle is a nerve-fibre connecting the protoplasmic mantle of the nettle-cell with the nervous system, and by means of this the movements of the protoplasmic mantle can be controlled. The explosion of the cnidoblast is caused by the contraction of the plasmatic coat which surrounds the capsule, and which in *Physalia* (as Chun has shown) is partially converted into a network of muscular fibres. This plasmatic contractile coat is incited to action by the cnidocil, for if anything touches the cnidocil the plasmatic mantle contracts, and the tube is shot forth. But the explosion is under the will of the animal, and can be prevented by means of the nerve-fibre connecting the cnidoblast with the ganglion-cells below. The apparently homologous cells of the Ctenophora do not explode, but appear to be subject to the will of the animal, as is the cnidoblast.

Genera of Plumulariidæ.*—Mr. W. M. Bale adds to his revision of the genera of Plumulariidæ some observations on various Australian Hydroids. With regard to Prof. Allman's division into the Eleutheroplea and the Statoplea it is pointed out that, while there is no single distinguishing characteristic which can be said to be invariable, it is generally easy to refer a species to its proper subfamily by its general facies, and by the predominance of the characters of one group over those of the other.

Differences in the mode of branching of the hydrocaulon are to be seen between the monosiphonic species, and those in which there is a compound stem, the stem and branches being simple jointed tubes in the former, while in the latter there are supplemental tubes which are obviously hydrorhizal elements.

Among the forms described or noted, *Sertularella johnstoni* and *Plumularia watsii* are new; the memoir concludes with some critical notes on recent papers by Allmann, von Lendenfeld, Kirchenpauer, and Quelch.

Medusæ of the Gulf-Stream.†—Mr. J. W. Fewkes gives an account of the Medusæ collected in the Gulf-Stream by the 'Albatross' in 1883–4; discussing the bathymetrical relations of the Medusæ, he refers to the important discovery at the surface of a new species (*Atolla Bairdii*) which belongs to a genus regarded by Prof. Häckel as one of the special deep-sea forms. *Nauphantopsis* is a new genus, distinguished from *Nauphanta* by the arrangement of its tentacles and the number of marginal lappets; *Ephyroides* g. n. is distinguished by having 16–32 or more radial ribs alternating with the same number of prominent marginal lappets; *Pterophyra*, with a general likeness to *Rhizophyra*, has two longitudinal wings on the polypites; for *Angelopsis* g. n. a new family of Angelidæ is necessary.

Parasitic Cuninas of Beaufort.‡ — Several larvæ of the group of *Cuninas* parasitic in the Geryonidæ were found by Mr. H. V. Wilson in the gastric cavity of *Liriope*.

The earliest stage noticed was a simple two-layered sac with a single mouth-opening. The next stage was similar, but had three mouths; and two tentacular protuberances by which it was attached. In the following stage a medusa bud was developed at the point of each mouth. In several points these stages differ from those described by Metschnikoff: e.g. no special part of the sac served as a stolon, but buds sprouted out all over the surface.

For the first time, *Cuninas* parasitic on other *Cuninas* are recorded from the American waters. They lie free in the stomach, are transparent, and

* Trans. and Proc. Roy. Soc. Victoria, xxii. (1886) 38 pp.
† Rep. Comm. U.S. Fish Commission, xii. (1886) pp. 927–77 (10 pls.).
‡ Johns-Hopkins Univ. Circulars, vi. (1886) p. 45.

have twelve to fifteen tentacles; they were found in eight tentacled forms, apparently *Cunoctantha octonaria.*

Addendum to the Australian Hydromedusæ.*—A fourth addendum is added by Dr. R. von Lendenfeld to his monograph: † besides the two species of *Hydra* already described by him, viz. *H. viridis* L. and *H. oligactis* Pallas, a third and new one is formed, for a species which invariably has six equal tentacles. *H. hexactinella* is perfectly cylindrical; colourless, except that the endoderm has a slightly yellow tinge. Two kinds of cnidoblasts with different cnido-cells are found on the tentacles. The author doubts the ganglionic nature of the cells described by Jickeli as such, as he finds no nucleus in them. These cells are interposed between the ectoderm and supporting lamella, and cause a protuberance of the former. These are deeply stained, and it is "not quite impossible" that they may be the nuclei of sensitive cells similar to the palpocils of Sarsia-polyps.

New Actinozoa.‡—Dr. W. Koch has described some new forms among the Actinozoa collected by Prof. Greeff on three islands of the Gulf of Guinea. One new Alcyonarian, three Gorgonias, one Antipathes, five sea-anemones, and four Madrepores. The histology of *Zoanthus* and *Palythoa* is also discussed.

Reef-corals of the 'Challenger.'§—Owing to the great interest which was found to attach to the corals collected in shallow water by the 'Challenger,' it was arranged that Mr. J. J. Quelch should write a short report on them; owing to the necessary limitations the greater part of this memoir deals with the description of genera and species; there were 293 species belonging to 69 genera; 73 of the species are new and eight of the genera. In addition to the descriptions, there is an important analysis of the geographical distribution, and there are valuable hints as to the analysis of the influence of local conditions (e. g. temperature, sunshine, composition of water, depth of growth) on the characters of the species.

Porifera.

Hindia.‖—Dr. G. J. Hinde, in a paper on the genus *Hindia*, opposes some of the statements of Prof. P. M. Duncan, urges that the sponge occurs under various mineral conditions, and especially throws doubt on the characters of the fossil alga *Palæachlya perforans*, which Dr. Duncan has been able to detect in a large number of various fossil forms.

Isoraphinia texta and Scytalia pertusa.¶—Herr C. Lahálka reports the discovery of the remains of these two marine sponges in the Turonian strata to the south of the heights of Rohatctz, near Raudnitz, in Bohemia, which appear to be in an excellent state of preservation. The author agrees with Zittel as to the generic position of the second form.

Protozoa.

Multiplication of Amœbæ.**—Mrs. (or Miss) Lillie E. Holman records that on the 4th July, 1886, she was examining the forms of life contained in a Holman life-slide, which had been filled for several hours. It con-

* Proc. Linn. Soc. N.S.Wales, x. (1886) pp. 679–81 (1 pl.).
† See this Journal, 1885, p. 252.
‡ 'Neue Anthozoen,' &c., 8vo, Marburg, 1886, 36 pp., 5 pls.
§ Report of the Voyage of H.M.S. 'Challenger,' Monograph, xlvi. (4to, London, 1886), 203 pp. and 12 pls.
‖ Ann. and Mag. Nat. Hist., xix. (1887) pp. 67–79.
¶ SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 647–52 (2 pls.).
** Proc. Acad. Nat. Sci. Philad., 1886, pp. 346–8.

tained different Infusoria, and, among other animals, specimens of *Æolosoma.* But it seemed for some time as if there were no *Amœbæ* in the slide, until a small one was discovered near the channel. In shape it seemed like an elongated triangle, and was rather torpid, or at least moved but little. The rest of the paper we transcribe in full.

"While I was examining it, it moved up closer to the line of the channel, and another *Amœba*, about twice the size of the first one, came gliding on the scene. It moved up very close to the other, and in a few minutes I noticed that it looked as if it were trying to swallow the smaller *Amœba*, and in the same manner that it does its ordinary prey. As I had watched many *Amœbæ* and had never seen anything like this, and as I knew they did not prey on each other, and the question of their conjugation was a very doubtful one, I dismissed the idea of the larger absorbing the smaller, and concluded it was merely the fact that they were in too tight a place to allow of their passing each other, which gave them this appearance. I watched them constantly for about half an hour, in course of which time I became convinced that somethfng unusual was going on.

The larger *Amœba* had entirely surrounded the smaller one, which, however, did not lose its vitality. First it seemed to be under the endosarc of the larger, and then above it. Sometimes it would project a pseudopod out from beyond the ectosarc of the larger animal. All the time it was distinctly visible in its own individuality, if one may so call it, and did not at all seem to be trying to escape. I called Mr. Holman's attention to the singularity of the behaviour, and expressed my belief that it was a case of either cannibalism or conjugation. He expressed his disbelief in either of these cases, and observing that the water in the slide was evaporating, we allowed a little to creep in under the closed edge of the cover-glass. This seemed to relieve the large *Amœba* from the constrained position and flat contour which it had assumed, and it immediately commenced to put out pseudopods and move away; and the smaller one moved off with it, evidently engulfed in the larger one, and quiescent in that position.

The small *Amœba* occupied a position in the upper part of the larger one. As this last moved on, it seemed to push the small one in an opposite direction from that which its granules were taking, till it reached about the centre of its body. Then it commenced an evident effort to expel the smaller one. It reached out its pseudopods in every direction, gradually expelling the smaller one until it was completely discharged. The smaller one by this time assumed an almost spherical shape.

At last the large *Amœba* ceased moving, and commenced to expel refuse matter such as is common with them. It had anchored itself near some other refuse matter, probably vegetable, and really looked as if it was using it as a sort of grapple for the purpose of ridding itself of the rejected smaller *Amœba*. It was successful; for in a few moments it moved away to the upper part of the field, leaving the round ball, looking in every respect like an encysted *Amœba*, near the little group of refuse. It went on in the field, and we followed it for some time, when it became quiet, and we went back to the encysted one. I watched it to see what would happen next, for it seemed as if there must be some strange sequel to our remarkable observation, and the watching was not in vain. The flat disc commenced by a sort of contractile movement to throw out particles or granules, as if it were laying eggs. I can think of no other expression, although the particles, while approximate in size, had not regularity of shape. This continued till the *Amœba* again assumed its clear and transparent appearance, and at last, seeming to fully regain its activity, put out a pseudopod and moved in the field, leaving behind it a group of particles or granules.

Only for a little while, however, did it move; in a few moments it lost its animation, seemed to become transparent, and at last faded into one of those discs which seem to be merely the shells of once active forms. I did not see it move again.

This observation was carried on continuously during two hours and a half, and every stage watched most closely. I was at a loss what to call it, if not a clear case of conjugation and separation.

The most convincing proof to my mind that this was a proceeding which was for a purpose, was given when, two nights after, this slide, which was laid carefully aside for future examination, was found to be full of young *Amœbæ*. They literally swarmed; I counted in the field at one time twenty-four of uniform size, while I have no hesitation in saying that there were between one and two hundred in the slide, which had before held but two. The worn-out disc was recognized, and also what seemed to be the remains of the larger *Amœba*."

Digestive Process in some Rhizopods.*—After a brief summary of the observations of previous writers, Miss M. Greenwood describes her own results, which were derived from experiments on *Actinosphærium* and on *Amœba*.

The act of ingestion.—In *Amœba proteus*, in which there is a more or less definite posterior extremity, it is this region that ingests most actively. The food is enclosed by the flowing out of two pseudopodia, which gradually close behind the prey. In the case of quiescent solid matter, very little fluid is included, but when the prey is active, more or less fluid is involved in a vacuole; but the amount depends on the activity of the prey to some extent. Ingestion was never observed in the anterior, moving region of the *Amœba*.

In *Actinosphærium*, the prey can be taken in anywhere; being captured by two pseudopodia, and enveloped in a film of hyaline protoplasm which advances from the side; very little water is included. The time taken in the process varies; sometimes the prey will swim away, after being in contact with the captor for an hour.

Changes undergone by ingested bodies.—The substances ingested are divided into four groups: (1) Starch, &c.; (2) Fat-globules; (3) Proteids (*a*) enclosed in a resisting wall or (*b*) "unshielded"; and (4) useless material, e. g. litmus. In *Amœba* the starch was extruded, after some hours or days, unaltered. Fat was likewise unaltered. Protococcus and Torulæ were observed as examples of protected proteids; the torulæ were unaltered, except for the loss of vacuoles; but in the case of chlorophyll-containing bodies, their green colour was changed to brown, after a day or two, indicative of some action on the proteid. Of "unshielded" proteids, *Monas Dallingeri* was noticed; the protoplasm became "turbid" after seven minutes; the flagellum broke down after fifteen minutes. The ingestive vacuole becomes digestive; but after the first changes on the food, it gradually disappears, and the resulting granules distributed about the *Amœba*. In the case of *Algæ*, though the change from green to brown indicates a change in the protoplasm, the cell-wall is not perforated; this therefore precludes the idea of "direct protoplasmic action," and indicates that the fluid in the vacuole diffuses through the cell-wall. Probably fresh fluid passes into the vacuole, and this then forms a vacuole of ejection; the act of ejection takes place with some force. But in the case of "unshielded protoplasm" no vacuole of ejection is formed. In *Actinosphærium* the starch grain was unaltered; the fat-globules appear to be acted on in some way,

* Journ. of Physiol., vii. (1886) pp. 253–73.

as the protoplasm round them becomes very granular, and a vacuole appears *gradually* after ingestion. The action on shielded proteid was the same as in the case of *Amœba*. As an example of "unshielded proteid," the digestion of a small Crustacean larva was observed; after eight hours its shape had been lost, and a vacuole had appeared. An Euglenoid form continued to struggle for $2\frac{1}{2}$ hours, but after 15 hours was disintegrated, though green colour remained. All ejecta are passed out by means of a vacuole. There is probably some difference in the process of digestion in *Amœba* and *Actinosphærium*.

The means by which the digestive changes are brought about.—Direct contact with the protoplasm is not necessary, so that the "secretion of some digestive fluid" must take place in the vacuole in *Amœba*. Innutritious material does not act as stimulus to the secretion; and ejection is in this case unaccompanied by any "viscid fluid." As to the nature of the digestive fluid, no very definite result is arrived at. Blue litmus remained unchanged for several hours. Methyl-violet and tropæolin were unsuccessful. But probably the secretion is *not acid*.

The paper concludes with a tabular statement of the changes observed continuously during the action of ingestion and digestion: (A) in *Actinosphærium* for ten hours; and (B) in *Amœba* for nine days.

Multiplication of Leucophrys patula.*—M. E. Maupas states that *Leucophrys patula* grows very rapidly, owing to its powerful buccal apparatus enabling it to be a voracious and successful carnivore. Its growth and its power of fission are in relation to this power of absorption—individuals isolated and placed in a rich medium divide four or five times a day, that is to say, one individual gives rise in twenty-four hours to thirty-two descendants. When, owing to its abundant multiplication, it has used up the great quantities of food at its disposal, this infusorian undergoes a series of remarkable and unique changes.

The individuals fix themselves to the edges of the drop of water in which they are living, and roll themselves up into a ball, as if they were going to encyst, but they form no cyst; the buccal apparatus disappears entirely, and the mouth is merely indicated by a shallow groove, which is difficult to detect; they then begin to undergo transverse division, but do not move nor eat afterwards; the divisions succeed one another rapidly, so that in a few hours each *Leucophrys* gives rise to sixty-four individuals. These take on an oblong cylindrical form and begin to move about; they are only 50 μ long and 19 to 20 μ broad, while their parents were 150 μ long and 100 μ wide. Had not their direct descent been observed it would be impossible to believe that they were derived from their parents, so different are they in all their characters.

For several days they exhibit great mobility, and are for the most part eaten up by the contemporaries of their parents who have not undergone division; later these latter do so. The products of division which have escaped being eaten by their relatives again become immobile, and during this period of rest they take on the typical form of the *Leucophrys* and re-form their buccal apparatus; when food is given them they absorb it at once, and rapidly grow up to the normal size of the species. No process of conjugation was, it is to be noted, observed at any stage. It would seem as if we had here to do with a species which preserves itself by autophagy. The observations of Claparède, Stein, and Balbiani on the dwarf forms of *Stentor cæruleus* may perhaps receive their explanation from the account here given.

* Comptes Rendus, ciii. (1886) pp. 1270–3.

Multiplication of Leucophrys patula.*—Prof. E. G. Balbiani, referring to the paper by M. Maupas, points out that *Leucophrys* affords only an example of facts already known; the formation or non-formation of a cyst adds nothing essential to the phenomena—thirty-three years ago Stein observed a similar mode of reproduction in *Colpoda cucullus*, and, in addition to other naturalists, M. Balbiani and his assistants have made similar observations. The latest form studied is now proposed to be called *Trichorhynchus tuamotuensis* g. et sp. n., found by M. Bouchon-Brandely near the Tuamotu Islands. These forms, after a few days' movement, become stationary and secrete a delicate cyst, in which they divide into two and sometimes into four new individuals, which emerge from the cyst on its breaking into two almost equal parts. This mode of multiplication goes on as long as there is nourishment in the fluid; when it fails the remainder encyst, and remain encysted, either entire, or dividing into two or four segments. The new genus is characterized by a tuft of long, stiff, diverging cilia which surround a conical protuberance which forms a kind of projecting lip above the mouth; the body is cylindrical, 0·04 mm. long and 0·028 mm. wide.

Zoothamnium arbuscula.†—Mr. J. Spencer describes the separation of the reproductive zooids from the colony. Around the base of a spheroidal zooid, near its attachment to the stem of the colony, a thread of protoplasm makes its appearance; this becomes an undulating ribbon, which then breaks up into a ring of cilia. Meanwhile the sphere has become biconical, and the ring of cilia gradually becomes equatorial and even nearer the opposite pole than to that where it started. This body now swims away. Its further fate was not followed. The ordinary zooids gradually disappeared from the colony during the above changes.

New Choano-flagellata.‡—Dr. A. C. Stokes describes three new species of these Infusoria.

Monosiga limnobia is especially noticeable in the equatorial position of the contractile vacuoles. This species seems able to live either in standing or in fresh waters.

Salpingœca eurystoma is characterized by the very wide mouth and everted edge of the lorica; to the bottom of which the animal is sometimes attached by a thread.

Desmarella irregularis forms colonies of fifty or more: the individuals being connected sometimes by a delicate thread of protoplasm, sometimes by being directly united laterally. This species is peculiar amongst the whole group of Choanoflagellata, in that the food is ingested at the *external* base of the collar: moreover the currents on the collar are reversed, being downwards, externally, and upwards, internally.

New Parasitic Infusorian.§—Herr Lindner reports the frequent occurrence, in the Kassel district, of a peritrichous Infusorian with parasitic habit. It occurs in foul water, in sewage, in the fæces and even in the urine of typhus patients, &c. Prof. Bütschli referred the form to the free-swimming stalkless *Vorticellæ*. Its general structure is Vorticella-like. Resting capsules are formed in unfavourable environment, and many forms are found closely united by a glue-like substance. Longitudinal division and conjugation were observed. The parasite feeds on fluid albuminoid

* Comptes Rendus, civ. (1887) pp. 80–3.
† Journ. Quek. Micr. Club, iii. (1886) pp. 5–7 (1 pl.).
‡ Amer. Mon. Micr. Journ., vii. (1886) pp. 227–8 (3 figs.).
§ Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1887) pp. 733–4.

material, and on *Bacteria*, both indifferent and virulent. It can thrive in the most varied media when albumen is present and free acid absent. The author describes the form as "ascoid."

Adelosina.*—M. C. Schlumberger is of opinion that to insure a successful study of the Miliolidæ it is indispensable to make delicate sections passing through the initial chamber. Starting, for a type, with *Adèlosina bicormis*, which is very common in the Mediterranean, he calls it form A, and then he compares with it another kind which he calls form B; considering these species and comparing them with three species of *Biloculina*, he finds that form A presents a special character common to all the individuals of each of these groups. In *Adelosina* it is a megasphere completely enveloped by the first chamber, which becomes lenticular; in *Biloculina* it is a megasphere with two series of chambers in two planes of symmetry; in *Triloculina* and *Quinqueloculina* the megasphere is surrounded with three or five series of chambers. In form B of all the four genera the microsphere is always surrounded by a cycle of five chambers. The author concludes that in the classification of the Miliolidæ the form A determines the genus, and form B the species. In *Spiroloculina*, however, it is to be noted that there may be an initial polymorphism in form A.

New Form of Sarcodina.†—Dr. R. Moniez describes a new and unique parasite, found in the visceral cavity of several species of Ostracoda and Cladocera, but especially in *Cypris salina*. A number of the extraordinarily variable individuals are described and figured, and the general characteristics, such as they are, are summed up as follows;—body flattened, of variable size and form, consisting of absolutely homogeneous protoplasm; reproduction by fissures which may appear at any point of the individual mother, and constrict off a mass of protoplasm which forms a new individual. The unique and enigmatical species is named *Schizogenes parasiticus*. Were it not a parasite, the author would place it without hesitation among the Monera, but making allowance for the probable degeneration, is inclined provisionally to rank it with the Rhizopoda as a new family of Sarcodina.

New Type of Sporozoa.‡—Dr. R. Moniez gives an account of *Gymnospora*, a new type of Sporozoa, which he found in a larva of *Vanessa urticæ*, and which appears to be one of the Coccidia; its spores differ from those of *Klossia* in having no thick investing membrane; as the test is black, the species may be called *G. nigra*.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.§

(1) Cell-structure and Protoplasm.

Growth of Plasmolysed Cells.‖—According to Herr G. Klebs, cells of *Zygnema* and *Œdogonium*, which have been plasmolysed in 10 per cent. glucose, retain their life for a long time in this condition, and exhibit phenomena of growth. The strongly contracted protoplasts of *Zygnema*

* Bull. Soc. Zool. France, xi. (1886) pp. 544–57 (1 pl.).

† Journ. Anat. et Physiol., xxii. (1886) pp. 515–23 (1 pl.).

‡ Bull. Soc. Zool. France, xi. (1886) pp. 587–94.

§ This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‖ SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 22, 1886. See Bot. Centralbl., xxviii. (1886) p. 156.

surround themselves with new strongly laminated cell-walls, grow greatly in length, take up the most various and abnormal forms, and divide in the ordinary way. The *Œdogonium*-cells form in this solution also new laminated membranes, scarcely increase in length, and divide, not in the ordinary way, but in that of *Cladophora*. These phenomena take place only in cane-sugar, grape-sugar, milk-sugar, and mannite, light being necessary to them. If *Zygnema* is placed in 10 per cent. glucose in the dark, it does not grow in length, and forms no new cell-walls; but the protoplasts remain alive for some weeks, till they gradually die of want of nutriment.

When elongated *Zygnema*-cells are plasmolysed, the protoplast breaks into two halves, one of which contains the single nucleus, the other having none. Only the portions of the cells which contain the nucleus form membranes, grow in length, and regenerate the entire cells; the parts which contain no nucleus have not the power of forming a cell-wall or of growing in length, but they may retain their life for a long while, increase in volume, and form starch.

Separation of Silver by active Albumin.*—Dr. T. Bokorny, referring to the observations of Loew and himself,† that living protoplasm blackens in a very dilute alkaline silver solution while dead protoplasm does not, replies to the explanation offered by Hoppe-Seyler that this is due to the presence in living organs of hydrogen peroxide (H_2O_2). If the least trace (1 part in 100,000) of H_2O_2 were present in the living cell, sufficient iodine would be set free from potassium iodide with a very dilute solution of iron sulphate to produce a sensible reaction with starch. Bokorny found, however, that this was not the case with *Spirogyra*-cells containing abundance of starch-grains, while the starch-grains imbedded in the protoplasm at once became blue if treated with a solution of H_2O_2 in the presence of the same reagents. In living *Spirogyra*-cells saturated with H_2O_2, and laid in a very dilute silver solution, the protoplasm rapidly blackened, while the cell-walls and cell-sap remained perfectly colourless, while dead *Spirogyra*-cells showed no reduction of silver whatever. The author concludes that the reducing property depends on the presence in living cells of a body (active albumin), which passes over on the death of the cell into a body not possessing this property. He found that the effect of H_2O_2 on this property of active albumin was at first to increase its activity, this being subsequently followed by its complete suppression.

(2) Other Cell-contents.

Crystalloids in the Cell-nucleus.‡—Crystalloids as a constant inclosure in the nucleus have hitherto been known only in *Lathræa squamaria*, *Utricularia*, and *Pinguicula*. According to Dr. H. Leitgeb, they occur also in *Galtonia* (*Hyacinthus*) *candicans*, especially in the epidermal cells of the perianth-leaves and stamens, but also in the cells of the mesophyll, in the epidermis of the flower-stalk, in the wall of the ovary, and occasionally in other organs and tissues of the plant, but always much smaller and less fully developed; it is only in the underground parts that they are not found. They have the form of prismatic rods, are seldom solitary, but usually in groups. They exhibit protein reactions, and may probably be regarded as reserve-substances. In *Pinguicula* they are, under certain circumstances, used up in the new formation of organs. In the perianth leaves of *Galtonia*, they are absorbed some time before the death of the

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 347–58.
† See this Journal, 1884, p. 249. ‡ MT. Bot. Inst. Graz, i. (1886) pp. 113–22.

cell, but their substance is probably used up in the processes which subsequently go on in the cell, for the absorption of the crystals takes place even in unfertilized blossoms. The absorption may be effected in various ways.

The formation of crystalloids appears to have a certain relationship to the production of flowers and fruit. In *Lathræa* they are found only in the flower-bearing stems; in *Pinguicula* they remain until the appearance of the blossoms. In contrast to other albuminous substances, crystalloids in the nucleus are either confined to the superficial cells, or are most abundant in them. In *Urtica* and *Campanula* they are found only in the trichomes.

Chromoleucites.*—The chromoleucites of flowers and fruits are stated by M. L. Courchet to be formed either from a stroma of proteinaceous character, which is generally colourless, or from pigment-granules of a certain degree of fluidity and of variable size scattered more or less regularly in the stroma. He enumerates five distinct types of pigment, viz.: (1) True crystals formed from the pigment alone without any admixture of protoplasm (root of carrot, fruit of tomato, melon, and cucumber). (2) Rounded, or of an irregular contour, with a homogeneous appearance, owing to the minuteness of the pigment-grains (berry of asparagus. (3) Spindle-shaped, or of the form of a plate with many points (fruit of honeysuckle). (4) The coloration is due to a coloured sap (ovary of *Salpiglossis*). (5) The colour is due neither to chromoleucites nor to a coloured sap, but to an orange-yellow coloration of the walls of the external cells (fruit of several species of *Solanum*).

Colouring Matter of Aceras anthropophora.†—Sig. P. Severino has studied the nature of the colouring matter in the flowers of the variety *purpurea* of the man-orchis. He finds it to be due to a solid granular substance which is probably a modification of chlorophyll.

Nägeli's Starch-cellulose.‡—Herr A. Meyer disputes the theory of the structure of starch-grains first put forward by Nägeli, and since generally adopted, that they consist of an intimate admixture of two distinct substances, true starch (granulose), and cellulose (farinose). The action on starch-grains of either saliva or concentrated sulphuric acid entirely removes the granulose, leaving behind a skeleton composed of a substance which has been termed amylodextrin.

According to Meyer, amylodextrin always results when starch-grains are treated with dilute acids, diastase, pepsin, or saliva, this being the first result of hydration at a low temperature, afterwards passing over into dextrin and soluble sugar, the skeleton also then entirely disappearing. It is difficult to obtain amylodextrin entirely free from dextrin and sugar; and this would be impossible were it not that it has a tendency to aggregate into sphero-crystals very similar to those of inulin; these sphero-crystals are occasionally disc-shaped, more often spherical, often laminated, and closely resemble centric starch-grains, even in their appearance under polarized light. Micro-chemical examination shows almost conclusively that the skeletons obtained by the action of acids and of saliva on starch-grains and amylodextrin, are identical substances. Amylodextrin and "starch-cellulose" are, therefore, not present in the intact starch-grain, but are products of the action upon it of hydrating agents, and there is only one substance present in normal starch-grains, which the author proposes to call "starch-substance."

* Bull. Soc. Bot. France, viii. (1886) pp. 178–81.
† Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 315–9.
‡ Bot. Ztg., xliv. (1886) pp. 697–703, 713–9.

There are, however, starch-grains which contain amylodextrin and dextrin, in addition to starch-substance; but they are readily distinguished from normal starch by being coloured red-violet or an intense red with iodine. The different behaviour of the different layers of starch-grains Meyer believes to depend on their different degrees of porosity, the substance of all the layers being destitute of water, and alike physically and chemically.

Presence of Glyoxylic Acid in Plants.*—MM. H. Brunner and E. Chuard consider glyoxylic acid to be formed by a process of reduction.

In the first place oxalic acid is produced by the reducing action of hydrogen on carbonic acid.

$$2H_2CO_3 + H_2 = 2H_2O + C_2H_2O_4.$$

Oxalic acid is then reduced in a similar manner to glyoxylic.

$$C_2H_2O_4 + H_2 = H_2O + C_2H_2O_3.$$

Erlenmeyer considers that the hydrogen in the above equation is obtained from water, which, under the action of light and chlorophyll, breaks up into hydrogen and hydrogen peroxide. Glyoxylic acid, on reduction, produces glycolic, tartaric, malic, and succinic acids.

The authors used various materials for the extraction of glyoxylic acid unripe grapes were first tried, but the quantity found was small. Better results were obtained with unripe pears and apples, and with the fruits and leaves of *Ribes Grossularia* and *R. nigrum.*

Glyoxylic acid may be considered as the first member of the series which contains formic, glycolic, and oxalic acids, and it is especially found in very young fruits at an early stage of their development. The other acids make their appearance and increase little by little as the fruit developes, while the first-named members decrease in quantity or even disappear at the moment of maturity. This is especially the case with glyoxylic acid.

Micro-chemistry of the Epidermal Tissue.†—M. J. Dufour describes a number of substances found in the epidermal tissue of plants, the study of which is specially interesting as throwing light on some of the physiological functions of that tissue. The substances he classifies under various heads.

(1) *Tannins.*—Tannin is widely distributed in the epidermal tissue; it occurs more frequently in the upper epidermis than in the lower, often presenting the appearance of drops of oil, but these are easily distinguished by their dissolving in water. Two principal forms are met with, which are distinguished by the colour given with salts of iron, one being blue and the other greenish-black. Examples of the first form are *Rhus glabra* and *Lythrum tomentosum;* of the second, *Bupleurum longifolium.* The epidermal tissue of ferns frequently contains tannin, as *Aspidium Lonchitis, A. Filix-mas, Cystopteris alpina,* &c.

On adding alcohol to an epidermal tissue, a colourless finely granular precipitate is sometimes obtained; this, the author states, is frequently due to tannin. Such a precipitate is obtained with *Lychnis Viscaria, Eranthis hyemalis,* &c., and with Leguminosæ and Umbelliferæ.

Iodide of potassium gives generally a brown or colourless precipitate with tannin; sometimes a yellow or orange colour is obtained, e. g. *Delphinium staphisagria* and *Daphne Laureola.*

* Bull. Soc. Vaud., xxii. (1886) pp. 162–9.

† Ibid., pp. 134–42.

A reaction worthy of special attention is that of tannin with osmic acid. If to a solution of tannin a little hydrochloric acid and then a few drops of osmic acid (1 per cent. solution) are added, an intense blue is obtained. With osmic acid alone a black colour is usually obtained; an exception to this is *Sedum Telephium*, which gave blue.

Usually the tannin is spread uniformly through the cells, but sometimes some of the cells become as it were reservoirs of tannin, while others contain watery cell-sap. In *Sedum Telephium* numbers of these reservoirs or idioblasts are found in both the upper and lower epidermides. They are easily recognized by being much larger than the adjacent cells. Those on the lower face of the leaf contain in addition a rose-coloured pigment.

With a salt of iron the ordinary cells give a greenish-black colour, and the idioblasts a bluish-black; we have here the two forms of tannin side by side. In the genus *Primula* a number of the species contain very characteristic idioblasts.

(2) *Soluble starch.*—This substance occurs in some plants, almost exclusively in the epidermal tissue.

(3) *Sphæro-crystals of Linaria striata.*—On treating fragments of the epidermis of this plant with alcohol, the sphæro-crystals are seen adhering to the walls of the cells. They are of a yellowish colour, and their organic nature can be demonstrated by the action of heat.

(4) *Crystals of calcium oxalate* sometimes occur in the epidermal cells. They are either enclosed in special cells (*Euonymus latifolius*), or are scattered sparsely in the ordinary cells (*Cynosurus cristatus*), or occasionally a mass of small crystals in various forms is found (*Commelyna communis*).

(5) *Crystalloids and analogous bodies.*—Bodies which belong to this class are found in the epidermal cells of *Campanula thyrsoidea.* They are coloured yellow by iodine, and swell up under the action of caustic potash.

(6) *Oil.*—Occasionally in epidermal cells and stomata, e. g. *Weigelia rosea*, *Hoya carnosa*, &c. Idioblasts containing oil are found in *Asarum europæum*, *Aristolochia rotunda*, and *Asperula taurina.* Those in the upper epidermis of *Asarum europæum* are 20–35 μ in diameter, those of the lower epidermis 40–70 μ long, 30–40 μ broad. The oil is coloured brown by osmic acid, and can easily be extracted by ether or alcohol.

(7) *Chlorophyll* is often present in epidermal cells, as has been already pointed out by M. Stöhr. In *Swertia perennis*, *Cucurbita Pepo*, &c., chlorophyll granules were found inclosing starch-grains.

(8) *Pigments.*—Rose-coloured pigments exist in the epidermal cells of certain plants. In *Anagallis arvensis* the pigment is confined to special cells.

The above substances can be classified in two categories from a physiological point of view.

(1) *The assimilating substance or chlorophyll.*—Where this substance occurs in abundance, as, for example, in ferns, the epidermal tissue produces starch largely.

(2) *Substances eliminated by the plant* in the course of its chemical transformations. Among these tannin, soluble starch, calcium oxalate, and oil may be mentioned. The epidermal tissue here acts as a reservoir for the substances which are no longer of service to the plant.

(3) And finally, *water*, in those plants where the epidermis plays the part of a reservoir, and contains the water required by the leaf for the function of transpiration.*

* Cf. *infra*, p. 261.

(4) Structure of Tissues.

Molecular Structure of Vegetable Tissues.*—From an examination of the polarizing phenomena of the cells and tissues of a large number of plants belonging to Cellular Cryptogams, Vascular Cryptogams, and Phanerogams, Herr N. J. C. Müller classes them under four types as respects molecular structure. In the first two types the molecules have a globular form, with the radial axis either longer or shorter than the two tangential axes, which are equal in length. In the two other types the molecules are cylindrical, with optical axes of three different lengths, one radial, another parallel to the axis of the cylinder, the third also tangential, but at right angles to the axis of the cylinder. Of these the longitudinal axis is always either the longest or shortest, the tranverse axis being always intermediate in length between the two others. The relative position of the axes is not unfrequently disturbed by torsion.

Nuclear Sheath.†—Dr. H. de Vries traces the presence of a nuclear sheath right up to the growing apices of roots; it is this layer, and not the pericambium, which limits the pressure, as is seen from the phenomena in older roots. These two layers form together a stratum of close cells without intercellular spaces. The currents of protoplasm in the various layers of tissue are described, and especially in the nuclear sheath. The granules pass here in a broad stream along the tangential and transverse walls. There is also a constant current of protoplasm in the living cells of all the layers of tissue in the young roots, and here also especially along the tangential and transverse walls. The direction of the current is such as to serve for the transport of water from the root-hairs to the vascular bundles, and of nutrient substances from the older parts of the root to the layers of growing tissue.

Annual Formation of Cork.‡—According to Herr A. Gerber, it is not in all trees and not in all seasons that the cork forms a distinct ring every year. He distinguishes three distinct types in this respect. The yearly increase of cork varies greatly, from one row of cells in *Salix* to 100 rows in *Quercus suber*. It is usually strongest in the first year, and nearly constant after that. The number of rows in cells stands in inverse proportion to the thickness of their walls.

Pericycle.§—M. J. d'Arbaumont expresses views somewhat divergent from those of Van Tieghem ‖ as to the origin of this tissue. He regards the central cylinder as divisible into two main parts or regions, one corresponding to the primordial conjunctive tissue comprising the pith and the whole or a portion of the primary medullary rays, the other to the secondary formative tissue, from which proceed, on the one hand the xylem, on the other hand the soft bast or pericycle.

In five herbaceous plants examined, the author found the pericycle to be a product of differentiation of an unbroken zone of formative tissue, independent of the primordial meristem, from which the soft bast and xylem proceed; this zone is an integral portion of the fibrovascular bundles. In the Cucurbitaceæ we find a different structure; the pericyclical layer is divided into two parts, one internal, parenchymatous, broken up, and remaining adherent to the xylem of the bundles, the other external, fibrous,

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 1–49 (4 pls.).
† Maandbl. v. Natuurwet., xiii. (1886) pp. 53–68. See Bot. Ztg., xliv. (1886) p. 788.
‡ Zeitschr. d. Naturwiss., iv. (1886) pp. 451–88.
§ Bull. Soc. Bot. France, viii. (1886) pp. 141–51.
‖ See this Journal, 1886, p. 266.

and continuous, localized at the periphery of the central cylinder, and separated from the bundles by several layers of fundamental tissue.

Commenting on this paper, M. L. Morot * maintains that both the pericycle and the pith may be entirely parenchymatous or entirely sclerenchymatous, or partly the one and partly the other; in the last case, the sclerification may be bounded at the outer or inner border of the vascular bundles, or may form a continuous zone, or may present a more or less irregular appearance.

Development of Tracheides.† — Herr L. Kny discusses the question whether elongated fibriform tracheides are, like vascular tracheides, developed out of a single cambial cell, or from a fusion of a number of cells. In Coniferæ, and in many Dicotyledones the former is certainly the case, but in many Monocotyledones with secondary growth in thickness, e. g. *Aloë*, *Yucca aloifolia*, *Dioscorea convolvulacea*, *Dracæna Draco*, and *Aletris fragrans*, he was able to determine that they were the result of the coalescence of several superposed cambial cells. In some instances, they are from 26 to 30 times the length of an ordinary cell, and contain at first as many nuclei as that number of cells of which they are composed. The ends of such fibriform tracheides are completely closed.

Central Cylinder of Stem.‡—MM. P. Van Tieghem and H. Douliot point out that in the cases described by de Bary as concentric bundles in which the xylem is internal and the liber external, the concentric bundles really consist of several central cylinders, resulting from the ramification of a single central cylinder. The disposition of the vascular bundles in the stem may be arranged under three types, viz. (1) A single central cylinder (*monostelic* structure); this includes all roots except those of Lycopodiaceæ, the greater number of the stems of Phanerogams, the petiole of Solanaceæ, Cucurbitaceæ, &c.; (2) Several central cylinders (*polystelic* structure); including the stem of species of *Auricula* and *Gunnera*, the greater number of ferns, Marsiliaceæ, Selaginellaceæ, and Lycopodiaceæ, the petiole of many ferns, and the root of Lycopodiaceæ; (3) Vascular bundles isolated, without any central cylinder (*astelic* structure); the stem of Nymphæaceæ, of *Hydrocleis*, and of several species of *Ranunculus*; the lamina of fern-leaves.

Structure of Crassulaceæ.§—According to M. H. Douliot, the stem and roots of Crassulaceæ are normal in their primary structure; but in the stem secondary formations occur, giving the appearance of a "polystelic" structure ‖ when the concentric foliar bundles increase in size. The same may take place in the root from divisions of the generating layer in several arcs; but the modification is here again secondary, and the "polystelism" only illusory.

Anatomy of Casuarineæ.¶—M. H. Lecomte has examined the anatomical structure of several species of *Casuarina*. He agrees with the prevalent view that the longitudinal ridges on the stem are of the nature of decurrent leaves, as is shown by their possessing a palisade-parenchyma and a special fibrovascular bundle in each rib. A transverse section of a young branch presents two concentric circles of vascular bundles, the outer of which belongs to the leaves, the inner to the central cylinder of the stem, its bundles being alternate with those of the outer circle. The course of the vascular bundles presents a striking analogy to that which

* Bull. Soc. Bot. France, viii. (1886) pp. 203–6.
† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 267–76 (1 pl.).
‡ Bull. Soc. Bot. France, viii. (1886) pp. 213–6.
§ Ibid., pp. 299–306 (7 figs.).
‖ See preceding note.
¶ Bull. Soc. Bot. France, viii. (1886) pp. 311–7.

occurs in the Equisetaceæ. The bud which is formed in the axil of each tooth of the sheath which incloses the base of each internode, receives its vascular system from the lowest region of each bundle of the internode above it. Each leaf is separated from the stem by a layer of suber.

Anatomical Structure of Loranthaceæ.* — Herr G. Marktanner-Turneretscher treats of the physiology and anatomical structure of *Viscum album*. Specially worthy of notice is the fact that the assimilating tissue, in its specific form as palisade-tissue, is not formed till the second year. The ends of the fibrovascular bundles were examined, and it was found that the tracheïdes terminated generally in a club-shaped swelling. The fibrovascular bundles in the leaf had no parenchymatous sheath. The stomata were found in all possible stages of development in the mature epidermis.

The author then describes the anatomical structure of *Loranthus europæus*. Periderm is found in the stem in an early period, and this constitutes one of the differences between *Loranthus* and *Viscum*. The deciduous leaves have no typical palisade-cells, and the fibrovascular bundles have no parenchymatous sheath. Frequently, as in *Viscum*, the tracheïdes end in a club-shaped manner. The formation of the water-receptacles is characteristic on the margin of the leaf near to the apex. They consist of a spherical aggregate of conical cells, which cells, on account of the constitution of their cell-walls, are known as mucilage-cells. The author points out the relation of these mucilage-cells to the ends of the fibrovascular bundles, and in conclusion states that rhombohedric crystals of calcium oxalate are to be found in the parenchyma of the stem.

Formation of Thullæ.†—Herr J. F. A. Mellink describes a peculiar structure in the leaf-stalk of *Nymphæa alba*, consisting of large cavities opening outwards by a narrow fissure, and reaching from the epidermis to the vascular bundles. The large air-cavities in the neighbourbood of these wounds were filled with hair-like structures resembling thullæ in their mode of development, since they result from the swelling of the parenchymatous cells which bound the intercellular spaces.

Epidermis as a Reservoir of Water.‡—According to M. J. Vesque, it is very rarely that the functions of the epidermis are confined to those of protection. Even when it is reduced to a single layer of cells, it serves, in the great majority of cases, also as a reservoir of water, giving it up to the assimilating tissue when the latter is in need of it. For this purpose it is necessary that the epidermal cells should possess the power of changing their volume, and that their osmotic properties should be less than those of the cells to which they give up their water. The mode is described in the paper by which this property of the epidermis was directly proved in the case of a large number of plants. The mean quantity of water given up in this way to the assimilating tissue is 40 per cent. of their maximum volume. The general absence of chlorophyll from the epidermal cells appears to be an adaptation to promote this function; water passes with very great ease from one cell of the epidermis to another.

Aquiferous System in Calophyllum.§—M. J. Vesque gives a comparative sketch of the arrangement of the aquiferous system in the leaves of certain species of *Calophyllum*, and sees in the variations in the arrangement of this system a means of classifying the species of this genus. Between the secondary nervures of the leaf, lying below the palisade-cells,

* SB. K. Akad. Wiss. Wien, xci. (1886) pp. 430–41 (1 pl.).
† Bot. Ztg., xliv. (1886) pp. 745–53 (1 pl.).
‡ Comptes Rendus, ciii. (1886) pp. 762–5.
§ Ibid., pp. 1203–5.

are certain secreting canals which run from the median to the marginal veins. The aquiferous system is closely related to these canals. It consists of spiral tracheïdes, terminating obliquely or in a point, which are grouped in a variable number of layers, embracing the lower and lateral surfaces of the secreting canal. More rarely they are united into a bundle lying completely below the canal, as in *C. trapezifolium* and *C. Thwaitesii*, or more rarely still, around the sides and upper surface, as in *C. Pseudo-tacamahaca*. This apparatus is present in all the species. It communicates with the bundles of the secondary veins by short fascicles of straight tracheïdes, and fibres, which traverse the parenchyma. The endoderm of the bundles is continued on the connecting fascicles and on the aquiferous system. The author considers the apparatus may either be a hypertrophy of the last ramifications of the fibrovascular system, the phloem of which is extinct or represented sometimes only by some elongated parenchyma cells, or it may consist of vascular reservoirs, due to the transformation of parenchyma cells, despite the presence of endoderm.

Vesicular Vessels of the Onion.*—In investigating the vesicular organs with the object of determining whether or not the transverse walls are perforated so as to place the cavities of successive segments in communication, Dr. S. H. Vines and Mr. A. B. Rendle have observed that, in the quiescent winter condition of the bulb, there are patches of callus—easily made conspicuous by staining with corallin—on the transverse walls. From this they infer that the transverse walls are perforated, the canals through them being open in the active, and closed by callus in the quiescent condition of the bulb, just as is the case with sieve-tubes. This inference has, however, to be confirmed by an investigation of the bulb in the active condition. The authors also observe that each segment of a vesicular vessel contains a large nucleus.

(5) Structure of Organs.

Origin of Lateral Roots.†—According to MM. P. Van Tieghem and H. Douliot, while the terminal root is sometimes endogenous, as in grasses, *Canna*, *Tropæolum*, &c., the lateral roots have almost always an endogenous origin, the only exceptions being in the Cruciferæ. The secondary roots of all orders are always endogenous, while adventitious buds are usually exogenous. With regard to the mode in which endogenous roots force their way to the surface, the authors differ from previous observers. It is not by compression and reduction, or any other purely mechanical mode, but by the absorption or actual digestion of the contents of the cells of the mother organ with which they come into contact. This purely physiological process was observed by them in the case of terminal, lateral, and secondary roots of a large number of plants belonging to a great variety of natural orders. If the cells attacked contain starch, this is first of all absorbed, then the protoplasmic contents, and finally the cell-wall.

The authors dissent from the conclusion of M. Mangin,‡ that the cortex of the root originates, in Monocotyledons, from the central cylinder. As the result of a large number of observations on plants belonging to different orders of Monocotyledons, they assert that in all cases the central cylinder of the root proceeds from the pericycle of the stem, while the cortex and the root-cap have a common origin in the internal layer of the cortex of the stem.

* Proc. Cambridge Phil. Soc., Nov. 8, 1886. See Nature, xxxv. (1887) p. 214.
† Bull. Soc. Bot. France, viii. (1886) pp. 252–4, 342–3.
‡ See this Journal, 1883, p. 241.

Changes in a Rooting Ivy-Leaf.*—M. E. Mer found that an ivy-leaf dipped in water by the free extremity of the petiole produced at that spot a cushion from which roots were developed. Placed then in contact with the soil, the roots increased and fixed themselves, and the root was kept alive for a period of seven years; there was no production of buds, as in *Begonia* leaves, to deprive it of its store of food-material.

During this period great changes took place in the tissues of the leaf. The petiole increased in diameter, as also the lamina in thickness by about one-third. The vascular bundles of the petiole had increased three to four fold in size, but without any development of sclerenchymatous elements. In the lamina, the palisade-tissue had increased to more than one-half the entire thickness of the leaf, the cells increasing greatly in length at right angles to the surface, and then dividing by septa parallel to the surface. This was especially the case with the parenchyma of the upper surface of the leaf.

Leaves of Grasses.†—Herr M. Güntz has examined the structure of the leaves of 132 species of grass with reference to their habit and mode of life. He finds that, as a rule, xerophilous grasses have erect narrow leaves, often channelled or folded, with strongly thickened cuticle, contrivances for the protection of the stomata by hairs or a coating of wax, and strongly developed tissue for the retention of water. Hygrophilous grasses, on the other hand, and those which grow in the shade, have usually flat leaves with only slightly thickened cuticle, free stomata, without any coating of wax, and, except in tropical species, but slender development of the aqueous tissue. The author further classifies, with respect to their habits and the structure of their leaves in four groups, viz.:—(1) Savannah grasses; (2) Meadow grasses; (3) Bamboos; and (4) Steppe grasses.

Coloured Leaves.‡—From an examination of the anatomical structure of a large number of coloured and variegated leaves, and of the physiological properties of their pigments, Dr. C. Hassack concludes that the white colour in variegated leaves results from the absence of pigment in the tissues, and the presence of numerous interstices filled with air between the cells; the reflection of light from the numerous air-bubbles in them causes the parts of the leaf which are really colourless to appear white. In leaves with yellow variegation, the normal chlorophyll is replaced by xanthophyll, which colours light-yellow the protoplasm collected into irregular parietal lumps, and occurs also in the form of minute granules. The grey-green, which often appears in coloured leaves in addition to white, is caused by white layers of tissue which lie above the green parts of the cells and partially obscure their colour. Silver-white spots on leaves with a metallic shimmer, are the result of an entire reflection of the light from large shallow air-cavities, which stretch between the colourless and the green layers of tissue in a direction parallel to the surface of the leaf. Red and brown tints are caused by the presence of anthocyan dissolved in the cell-sap, partly in the epidermis only, partly in the parenchyma only, partly in both tissues. The various tints depend on the intensity of the colour, and the concurrence of red cells with green, yellow, or white portions of tissue. A papillose structure of the epidermis, peculiar trichomes, or, in a few cases, a wavy structure of the entire leaf, is the cause of the velvety sheen of

* Bull. Soc. Bot. France, viii. (1886) pp. 136–41.

† Güntz, M., 'Unters. über d. anatom. Structur der Gramineenblätter,' 70 pp. and 2 pls., Leipzig, 1886. See Bot. Centralbl., xxviii. (1886) p. 201.

‡ Bot. Centralbl., xxviii. (1886) pp. 84–5, 116–21, 150–4, 181–6, 211–5, 243–6, 276–9, 308–12, 337–41, 373–5, 385–8 (1 pl.).

many leaves; the apices of the papillæ have the effect of bright points on a dark ground, the light being reflected from them in one direction only, while their lateral surfaces scatter the light.

While albinism is the result of degeneracy, Dr. Hassack regards a red colour as a direct consequence of light, and as a contrivance to protect leaves from the destructive action of too strong light on the chlorophyll, and too strong respiration; it is hence found especially in young leaves, or in the leaves of those plants which grow in very high altitudes, or in very cold latitudes.

Relationship of the Anatomical Structure of Leaves to their Origin.* —M. L. Dufour states that, in those leaves in which the normally upper and under surfaces become reversed in the course of growth, either the anatomical characters of the two surfaces become completely changed with their relative position, or some of the original differences remain unchanged. The former is the case with *Alstrœmeria psittacina* and *Allium ursinum*, the latter with *Allium nutans* and other species, *Eustrephus angustifolius*, and a large number of grasses. The fibrovascular bundles never undergo any change of position or of structure with the reversal of the position of the leaves; the characters most liable to change are the distribution of the stomata, the position of the palisade-parenchyma, and the relative degree of hairiness.

Petiole as a Taxonomic Organ.†—According to M. L. Petit, a transverse section of the terminal portion of the petiole may, within certain limits, be used for the purpose of determining the natural order to which a plant belongs. The following are the principal variations in its characters:—A. The transverse section exhibits secreting canals; *a*, a certain number of these canals are arranged regularly behind the peripheral bundles; (1) no crystals, bundles isolated, near the epidermis (Umbelliferæ); (2) usually macles, bundles isolated or united into a ring, near the centre (Araliaceæ; *Hydrocotyle* is intermediate between these two); *b*, secreting canals arranged irregularly; (1) macles, bundles united into a ring (some Malvaceæ); (2) no macles, bundles distinct (some Compositæ). B. The transverse section exhibits no secreting canals; *a*, bundles bicollateral; (1) median bundle well developed; α, laticiferous tubes (Asclepiadeæ, Apocynaceæ); β, laticiferous cells arranged in rows (Convolvulaceæ); γ, no laticifers, crystalline granulations (Solanaceæ); δ, no laticifers, macles (Myrtaceæ); (2) bundles nearly equal, no crystals; *b*, no bicollateral bundles; (1) macles, under this class are included a large number of minor variations; (2) no macles, α, numerous crystalline granulations in the same cell (some Chenopodiaceæ); β, crystals solitary (some Leguminosæ); γ, no crystals (to this class again belong a number of varieties, distinguished by smaller differences).

The author suggests that these characters may be useful in assisting to determine the position of fossil plants.

Structure and Physiology of Stomata.‡—Dr. H. Leitgeb has tried the experiment of separating the guard-cells of stomata from the adjacent epidermal cells and subjecting them to the action of stimuli, to which he found them very sensitive, and capable also of preserving their vitality for an extraordinarily long period. The experiments were made chiefly on the epidermis of the perianth-leaves of *Galtonia candicans*, in which the posterior wall of each guard-cell is connected with the opposite wall of the

* Bull. Soc. Bot. France, viii. (1886) pp. 268–75.
† Comptes Rendus, ciii. (1886) pp. 767–9.
‡ MT. Bot. Inst. Graz, i. (1886) pp. 123–84 (1 pl.).

adjoining epidermal cell by strands of cellulose, which afterwards become cuticularized.

In accordance with previous observations, he finds that, under normal conditions, the stomata are always open in bright daylight, the opening being effected by the turgidity of the guard-cells. It must not, however, be assumed from this that the turgidity of the guard-cell decreases at night, since in all the other cells it increases. In *Potamogeton natans* he found the guard-cells always open at night under normal conditions, this being the result solely of the turgid condition of the adjacent cells. The stomata of native Orchideæ and native Liliaceæ exhibit the peculiarity of opening instead of closing in water, this resulting from the ordinary epidermal cells losing their vitality much sooner than the guard-cells. In these plants the stomata do not close at night.

With regard to the closing of stomata at night, Dr. Leitgeb finds that, in contrast to the large number of plants in which the stomata are closed at night, there are certainly not fewer in which, under the same vital conditions, they do not close. All plants do not show the same phenomena when light is artificially shut out for a short time; the stomata may either close completely or not. Even in nature, however, plants belonging to both these categories do not behave alike; and in some the opening or closing of the stomata in light or darkness can be brought about at pleasure. In all circumstances the stomata close as the result of too great dryness of the soil, and commonly, even before the plant is observed to wither. In some plants the stomata partially close in direct sunlight, even with an abundant supply of water. In many, when the soil is sufficiently moist, the condition of the stomata is determined by the degree of moisture of the surrounding air, and is altogether independent of light. But all plants do not behave alike in this respect; an atmosphere saturated with moisture is unfavourable in some, while it promotes in others the closing of the stomata. It is therefore probable that the closing of the stomata at night is, where it takes place, not an immediate result of the withdrawal of light, which causes a decrease in the turgidity of the guard-cells; but that it is brought about by the lateral pressure of the epidermal cells against the stoma, which pressure increases with the increasing turgidity of the plant or of the organ which bears the stomata.

Anatomy of Stipules.*—M. G. Colomb proposes to define the term stipule more exactly than heretofore as any appendicular organ inserted on the stem, the vascular system of which is formed exclusively of branches of the foliar bundles before these have emerged from the cortex. He illustrates this definition in the cases of the hop, *Viola tricolor* and *striata*, *Galium*, *Rubia*, the honeysuckle, *Centranthus*, *Sambucus*, and others.

Peltate Hairs.†—Herr O. Bachmann has examined the structure of the peltate hairs in a large number of species belonging to many different orders. The commonest form, which he regards as the typical, is where each cell has the form of a narrow wedge, all these wedges radiating from the centre and united into a single plate, with or without a distinct stalk.

This may be varied by the cells being conically elevated in the centre, giving a cup-like form to the structure, or divided by cell-walls in different directions, or by the centre being modified in various ways. Thus, instead of being a point, it may be a line; or it may be raised into a globular form. The cells of which the peltate structure is composed may consist of two or more layers; or, on the other hand, it may be composed of two cells only.

* Bull. Soc. Bot. France, viii. (1886) pp. 288–94 (6 figs.).
† Flora, lxix. (1886) pp. 387–400, 403–15, 428–48 (4 pls.).

In some instances it is composed of two sets of cells, those springing from the centre not reaching the margin, and those springing from the margin not reaching the centre.

Herr Bachmann describes the peculiarities of these hairs in the various species examined, and discusses the value of characters derived from them for the purpose of classification.

Zygomorphy of Flowers.*—Herr H. Vöchting distinguishes three different sets of causes as producing zygomorphy in flowers, viz.:—(1) Gravitation only, (2) gravitation acting on the constitution of the organs, (3) the constitution of the organs alone. In the first type, which he terms zygomorphy of position, the flowers are always at first actinomorphic or regular, becoming subsequently zygomorphic. In all the plants examined belonging to this type, with the exception of *Epiphyllum truncatum*, the flowers are lateral, and all the members of the same whorl are affected by geotropism of the same kind, positive or negative. In that species the flowers are terminal, and it exhibits in other ways exceptional phenomena. Closely connected with the form of the flower is the curvature of the flower-stalk. Plants very closely allied to one another exhibit the greatest differences in the mode in which their zygomorphy is manifested. The curvature of the stalk is sometimes the result of inner, sometimes of outer causes; and with the same origin on the axis, and the same horizontal position of their own larger axis, the flowers are sometimes actinomorphic, sometimes zygomorphic, the latter property being sometimes produced by gravitation, sometimes by internal causes.

Double Flowers.†—Herr K. Goebel discusses the question of the doubling of flowers, chiefly from a horticultural point of view, and gives the results of a large number of observations. These observations, chiefly those made on *Leucojum*, show that from stocks with single flowers, seeds can be obtained by selection which will produce a larger and larger proportion of individuals with double flowers up to even 90 per cent. or still more; and from this he draws the conclusion that there must be a tendency towards doubling in the seeds borne by single flowers. The seeds which will produce double flowers can be distinguished by their smaller size and abnormal forms, from those which will produce ordinary single flowers. The various modes of doubling are described, resulting from the reversion of stamens to the condition of petals and from the increase in the number of petals or of corolline whorls.

Ovuliferous Petals in Caltha palustris.‡—M. L. Mangin calls attention to examples of flowers of this plant possessing two small supplementary petals [sepals] within the ordinary ones, which bore on their margins one or two rows of small buds. Each of these buds consisted of a nucellus protected by an integument and containing an embryo-sac, in which could be detected an oosphere, two synergidæ, antipodal cells, and a vegetative nucleus.

Inferior Ovaries.§—Herr K. Goebel discusses the two views as to the development of the inferior ovary: that of Koehne and Van Tieghem, that it is the result of coalescence of the basal portions of the sepals, and that of Schleiden, Payer, Hofmeister, and Sachs, that it arises from a hollowing out of the receptacle before the foliar organs have begun to be

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 297–346 (5 pls.). Cf. this Journal, 1886, p. 472.

† Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 207–96 (5 pls.).

‡ Bull. Soc. Bot. France, viii. (1886) pp. 262–3.

§ Bot. Ztg., xliv. (1886) pp. 729–38 (1 pl.).

formed. From an examination of the history of development of the inferior ovary of Compositæ and the superior ovary of Nymphæaceæ and Ranunculaceæ, and a comparison of the inferior ovary of Umbelliferæ with the superior ovary of *Acer*, he comes to the conclusion that in the inferior ovary there is no true coalescence of sepals; but on the other hand, the foliar organs do take part in the formation of the cavity even of the inferior ovary. He further disputes that there is any essential difference between the true inferior ovary and the so-called apparently inferior ovary of the Pomaceæ.

Extra-floral Nectaries of Hodgsonia heteroclita.*—Mr. W. Gardiner describes the gland-bearing organs which are found in *Hodgsonia*, one in the axil of each of the foliage leaves. A study of the development of these organs demonstrates that they are peculiarly modified leaves, or rather bracts, since they are associated with the rudimentary flower-bud. They are doubtless identical with the similar modified bracts which occur in connection with the fully developed flowers. The glands are found on the lower surface of the bract, and belong to the same type as those of *Luffa*, although of a distinctly higher order. Glands of a similar nature also occur on the under surface of the foliage leaves and on the sepals. The substance secreted by the glands is most probably of the nature of nectar, and the whole structures are to be regarded as extra-floral nectaries.

A careful survey of the various gland-bearing genera of the Cucurbitaceæ and Passifloraceæ, and a comparison of such cases as those presented by *Passiflora quadrangularis* and *P. fœtida*, place it beyond doubt that the function of the extra-floral nectaries of the two orders is to attract certain insects—probably ants—which are of service to the plant in protecting it from the attacks of other and harmful insects, such as caterpillars. As regards the fertilization of *Hodgsonia*, there are special contrivances to prevent the animal which feeds upon the nectar of the flower from obtaining that of the extra-floral nectaries, and *vice versâ;* it is exceedingly probable that fertilization is accomplished through the agency of a large night-flying moth.

Extra-floral Nectaries of Amygdaleæ.†—Sig. L. Macchiati describes the nectariferous glands on the young leaves of *Persica vulgaris*, *Amygdalus communis*, *Prunus domestica*, and *Cerasus vulgaris*. The size of the nectaries varies with the time of day, the maximum size being early in the morning, and the minimum in the afternoon. While in tropical America the purpose of extra-floral nectaries is to attract destructive ants of the genus *Œcodoma*, those of European plants serve in most cases to protect the flowers against the attacks of caterpillars. On the mature leaves the glands have altogether disappeared.

Succulent Fruits.‡—Dr. P. Lampe classifies the various kinds of succulent fruits into (1) berry, (2) drupe, and (3) pseudocarp (forms of *Cratægus*, *Mespilus*, *Cotoneaster*, and *Sorbus*), and describes the peculiarities of the special structure in the cases of a number of wild and cultivated species.

Contrivance for dispersing the Fruit of Scutellaria galericulata.§—Dr. M. Kronfeld calls attention to a structure peculiar to this plant among Labiatæ. The nucules of which the fruit is composed are one after another ejected through the tube formed by the upper part of the persistent calyx,

* Proc. Cambridge Phil. Soc., Nov. 8, 1886. See Nature, xxxv. (1887) p. 214.
† Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 305–7.
‡ Zeitschr. f. Naturwiss, v. (1886) pp. 295–323.
§ Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvi. (1886) pp. 373–5 (4 figs.).

this purpose being assisted by the elasticity of the fruit-stalk. The ejection of the nucules in a particular direction is secured by this contrivance.

Raphides-cells in the Fruit of Vanilla.*—As a general rule, the raphides-cells in the stem and leaves of Monocotyledons are characterized by preserving their division-walls intact. M. L. Guignard has noticed that in the ovary of *Vanilla aromatica* are cells arranged in rows containing a gummy matter and bundles of crystals of calcium oxalate. The walls which separate these cells from one another have in many cases disappeared owing to their perforation by the raphides.

Efficiency of the defensive structures of Plants.†—Dr. L. Errera classifies the means of protection of plants against animals under three heads:—(*a*) biological, (*b*) anatomical, and (*c*) chemical. Under the first he places those plants which grow in inaccessible situations, or by their dense growth form impenetrable thickets, or those which owe their existence to protective resemblance. Under the second head come spines, prickles, stings, &c., and the various modifications by which plants become hardened, thereby rendering them unfit for animal food. In the third division are the various chemical substances contained by plants, i. e. acids, tannins, essential oils, bitter principles, glucosides, alkaloids, &c.

The author also classifies plants into those which are sought after, shunned, or neglected by animals. Taking his examples from the Belgian flora, the author gives the percentage of the genera which come under each heading. With coriaceous or scabrous plants, 49 per cent. of the genera are shunned; with prickly or stinging plants, 35 per cent.; with plants containing an essential oil, 44 per cent.; with plants containing a bitter principle, 26 per cent., a glucoside, 28 per cent., and an alkaloid, 9 per cent. The percentage of the genera of those which are sought after is between 35 and 41; the remainder being those that are neglected.

In conclusion the author hopes that this much-neglected branch of botany will not be overlooked in the future, those plants showing protective resemblance being worthy of special study.

β. Physiology.‡

(1) Reproduction.

Reproductive Organs of Hybrids.§—The sterility of hybrids is exhibited more frequently in the imperfect development of the male than of the female organ. M. L. Guignard has studied the structure of pollen-grains when atrophied through the agency of hybridity. Where the stamens are not converted into staminodes, their arrest of development may be exhibited in various degrees. Very frequently the pollen-grain has only a single nucleus instead of two. The young pollen-grain may then be altogether arrested in its development; or it may put out a tube which penetrates the stigma, but which has only a germinating and no reproductive power, as in some *Begonias*. In other cases the pollen-grain—which may even be larger than the ordinary grain—has both its nuclei, but is still destitute of the power of impregnation. In a few cases there are more than two nuclei.

* Bull. Soc. Bot. France, viii. (1886) pp. 348-50.

† CR. Soc. R. Bot. Belg., 1886, pp. 86-104.

‡ This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

§ Comptes Rendus, ciii. (1886) pp. 769-72.

The ovules also, though apparently of normal size and form, usually display some degree of functional atrophy. In hybrid *Begonias* in which the stamens are transformed into staminodes, the ovules are destitute of an embryo-sac. In other cases, even when the number of ovules is reduced below the normal, they still retain their fertility when the pollen-grains have become altogether sterile.

Hybrid-pollination.*—Prof. E. Strasburger gives the results of a large number of further experiments on the extent to which pollen-grains from one species will germinate on the stigma of another species. His observations and experiments have led him to the conclusion that the pollen-grains contain a diastatic ferment, which can often be readily recognized by its rapid and energetic action on starch-paste. This ferment appears to be of the greatest importance to the nutrition of the pollen-grains as their tubes pass through the tissue of the style. It is probable also that there are other ferments which have the property of attacking cellulose, that it is the action of this ferment which enables the pollen-tube to pierce cell-walls, and that the nature of the ferment must differ in different species. The action is probably the same in the hyphæ of parasitic fungi which penetrate the host. The same explanation may be offered of the penetration of the pollen-tube into the embryo-sac, and of the general capacity for pollen-grains to impregnate only ovules belonging to their own species.

Vitality of Pollen-grains.†—M. L. Mangin has experimented on this subject with pollen-grains from a number of different species, when germinating both naturally and on specially prepared nutrient solutions. For the latter he finds a convenient preparation to be agar-agar softened and dissolved in boiling water, glucose, saccharose, gum, or dextrin being then added. The period during which the pollen-grains retain their power of germination varies between one day in the case of *Oxalis Acetosella*, and eighty days with *Narcissus pseudo-narcissus* and *Picea excelsa*. As a general rule the germinating period is short for those species which remain in blossom for a long while. The rapidity with which the grains germinate after coming in contact with the nutrient fluid also varies, some putting out their tubes immediately, others not till after the lapse of several days. Light has a favourable effect on the growth of some pollen-grains, an unfavourable effect on others.

Fertilization of Achlys triphylla.‡—Dr. S. Calloni describes the structure of the flower of this species, a native of western North America, which differs from the typical Berberideæ in being dichogamous and in the absence of a nectary, and apparent absence also of a corolla. In the first two of these points it approaches the Lardizabaleæ. It is proterandrous and anemophilous.

Fertilization of Aconitum Lycoctonum.§—According to Herr C. Aurivillius the flowers of this plant are dimorphic, some having the spur straight, others curved upwards into nearly a semicircle. The plant is strongly proterandrous, and is visited largely by humble-bees, and apparently hardly at all by any other insects. Of these some have a proboscis too short to reach the nectary at the base of the spur; these bite through

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 50-9 (1 fig.). Cf. this Journal, 1886, p. 279.

† Bull. Soc. Bot. France, viii. (1886) pp. 337-42.

‡ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 452-9.

§ SB. Bot. Sällsk. Stockholm, Feb. 17, 1886 (2 figs.). See Bot. Centralbl., xxix. (1887) p. 125.

the spur, and take no part in the fertilization of the ovules, which is effected only by long-styled bees.

The author points out the great difference in structure between the proboscis of a humble-bee and that of a butterfly, the former being able to turn the tip about in all directions, and thus obtain the honey from a spur even when its apex points upwards, which is not the case with Lepidoptera.

Fertilization of Cactaceæ.*—In opposition to the assertion of Kruttschnitt,† M. L. Guignard states, from observations on several species of *Cereus*, that fertilization is effected in the ordinary way by the pollen-tubes penetrating the conducting tissue of the style and entering the micropyle of the ovules. The structure of the ovary and ovules presents, however, several peculiarities. The very long funicles branch, in *C. tortuosus*, into as many as thirty branches or secondary funicles, each terminating in an ovule. The campylotropous ovules are thus brought into the very centre of the ovary, and the conducting tissue of the ovary consists of a number of papillæ or hairs containing starch-grains, which clothe the concave side of the primary and secondary funicles. In *C. tortuosus* not more than one-twentieth of the ovules are impregnated. M. Guignard was unable to detect any perforations or punctations at the apex of the pollen-tube, and believes that the passage of its contents into the oosphere takes place by diffusion. He regards the synergidæ as playing an essential part in the impregnation of the oospheres, though their exact function is still uncertain. In *C. tortuosus* it may be as much as three weeks after pollination before the pollen-tubes reach the ovules.

Fertilization of Cassia marilandica.‡—Mr. T. Meehan describes the mode in which the flowers of this plant are fertilized by humble-bees, the only mode in which fertilization can take place. The anthers do not split longitudinally, but have a terminal pore, covered by a membrane; the bees burst this membrane, and force out the pollen through the open pore. Mr. Meehan maintains that the dependence of a plant on insect aid for fertilization is an indication that its race is nearly run, and that it is on the downward track in the order of nature.

(2) Germination.

Loss of Nitrogen by Plants during Germination and Growth.§—Mr. W. O. Atwater and Mr. E. W. Rockwood give the details of some experiments, which consisted in causing peas to germinate under appropriate conditions, and cultivating the germinated plants for a longer or shorter time in water or sand. The nitrogen in the seed at the outset was estimated by determining the nitrogen in other peas in the same lot; in the germinated seeds or young plants it was determined directly. The general conclusions arrived at may be summarized as follows:—

(1) The decomposition of nitrogenous organic matter, living and dead, and of nitrates as well, is often attended by the evolution of nitrogen in either the free state or in its compounds, or in both. This liberation of nitrogen is sometimes, if not always, due to microbes.

(2) The germination of seeds is sometimes, but not always, accompanied by loss of considerable quantities of nitrogen. The balance of evidence seems decidedly to favour the hypothesis that germination without microbes and without the liberation of nitrogen is the normal process.

* Bull. Soc. Bot. France, viii. (1886) pp. 276–80.
† See this Journal, 1885, p. 270.
‡ Proc. Acad. Nat. Sci. Philadelphia, 1886, pp. 314–8.
§ Amer. Chem. Journ., viii. (1886) pp. 327–43.

(3) In this view both the action of microbes and the liberation of nitrogen either in the free state, or in the lower oxides or ammonia, must be regarded as simply forms of decay. They would thus be not essential to germination and growth, but accessory phenomena like the zymotic diseases that attack higher organisms.

Effects of the Temperature of Melting Ice on Germination.* — From experiments performed on a number of seeds, M. C. De Candolle concludes that it is impossible for germination to take place at the freezing-point when care is taken that there be no local heating of the soil in contact with the seeds themselves.

Desiccation of Seeds of Aquatic Plants.†—Prof. F. Ludwig calls attention to Fritz Müller's observation, that the seeds of some aquatic plants, such as *Eichhornia* and *Heteranthera*, seemed to require desiccation as a preliminary to germination. Some seeds of *Mayaca fluviatilis*, dried for six weeks during their conveyance from F. Müller to Professor Ludwig, germinated immediately after being sown, while others of the same lot, sown directly in water by F. Müller, had made no progress even after the lapse of three months. A. Braun noted a similar necessity for desiccation in the alga *Chlamydococcus pluvialis*. Fritz Müller notes the case of *Pistia*, where it seems that the seed must come to the surface and in contact with the air before germination; if this be prevented by entanglement, &c., germination does not take place.

Birds as Disseminators of Seeds.‡—Sig. A. Piccone records a list of twenty-three species of plants, natives of Liguria, nearly all trees and shrubs, the seeds of which are disseminated by passing through the body of birds and being voided with the excrements. He notes that the gizzard is wanting in the greater number of birds of passage and in those which live on insects or on soft and fleshy fruits.

(4) Growth.

Correlation of Growth.§—Dr. M. Kronfeld gives examples of Goebel's law of correlation of growth, viz. that if any organ is suppressed, the organ dependent on it will grow more vigorously in order to make up the loss. He found this to take place to a remarkable extent with the stipules of *Vicia Faba* when the leaves had been removed. With the small narrow stipules of *Phaseolus multiflorus*, *Rosa semperflorens*, *Rubus fruticosus*, and *Idæus*, *Sida Napæa*, *Trifolium filiforme*, *Urtica urens*, and the leafy auricles of *Pyrethrum indicum*, no corresponding increase took place. In *Pyrus Malus*, in one experiment out of five, one stipule increased in superficies about 100 per cent. With *Pisum sativum* the leaves and stipules each grew more rapidly when the other was removed, and flowers were produced in both instances.

Terminal Growth of the Root in Nymphæaceæ.‖—In addition to the points of difference already recorded between the Nelumbeæ and the true Nymphæaceæ, M. P. Van Tieghem points out that in the former the root-cap and piliferous layer of the root are derived from the same initial cells, which are independent of those of the cortex; while in the latter the root-cap is altogether independent in its origin of the piliferous layer which proceeds from the same initial cells as the cortex. This point is of con-

* Ann. Sci. Phys. et Nat., xvi. (1886) pp. 322–3.
† Biol. Central., vi. (1886) pp. 299–300.
‡ Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 286–91.
§ Bot. Ztg., xliv. (1886) pp. 846–9.
‖ Bull. Soc. Bot. France, viii. (1886) pp. 264–5.

siderable importance, since the latter relationship had hitherto been observed in Monocotyledons only.

Gliding Growth in the Formation of the Tissues of Vascular Plants.*— The term "gliding growth" (gleitendes Wachsthum) is applied by Herr G. Krabbe to that mode in which the cell-walls of neighbouring cells become pushed or glide one over another; and he points out the importance of this process in the differentiation of tissues. Any increase in the tangential diameter of vessels can, he maintains, take place only on this supposition. A very simple instance of this mode of growth occurs in the formation of the cambium-ring. The author believes also that it assists in the formation of vascular cells, sieve-tubes, tracheïdes, libriform, and bast-cells. When cells increase in volume in this way, no increase in turgidity need be assumed, the cause of growth being an active growth or specific activity of the cell-wall where it is in contact with the protoplasm. This view is inconsistent with the hypothesis of a universal continuity of protoplasm from cell to cell.

Influence of an Aquatic Medium on Amphibious Plants.—M. E. Mer,† replying to the objections of Costantin,‡ adheres to his conclusion that modifications which survive in the form and structure of amphibious plants in consequence of a change of medium—the only ones on which it is possible to experiment, because they are the only ones which can survive in either air or water—must be considered as the result—not of a direct influence, but of a slow and prolonged action of the medium, transmitted by heredity. He supports this view from the structure of the very plants which Costantin relies on to prove the contrary.

To this M. J. Costantin replies, § adducing instances in which he conceives that no other explanation can be offered of the alteration of structure in organs caused by complete submersion than that it is the direct result of the action of the medium on the organs.

(6) Movement.

Transpiration. ||—Herr F. G. Kohl enters in great detail into the phenomena attending this function. In opposition to the statements of Haberlandt and Wiesner, he finds that cut plants when moistened wither less rapidly than when dry. Moistening with water causes the stomata to close or not, according to the structure of the neighbouring epidermal cells. When the guard-cells are the only epidermal cells which contain chlorophyll, the stomata open in light; but if the other cells of the epidermis also contain chlorophyll, the effect is slight or none at all. With regard to the influence of temperature on the stomata, the author confirms the observations of Schwendener and Sorauer that a rise in temperature favours transpiration, whether of the air or of the ground. Plants destitute of stomata, as *Trichomanes radicans*, transpire less in the dark than in diffused light.

A number of experiments were undertaken in order to ascertain the effect of stronger or weaker transpiration on the development of tissue. As a general result it is stated that plants grown in dry air exhibit a tendency to stronger thickening and cuticularizing of the outer walls of

* Krabbe, F., 'Das gleitende Wachsthum bei der Gewebebildung d. Gefässpflanzen,' 100 pp. and 7 pls., Berlin, 1886. See Bot. Centralbl., xxix. (1887) p. 3.

† Bull. Soc. Bot. France, viii. (1886) pp. 169–77.

‡ See this Journal, 1886, p. 474.

§ Op. cit., pp. 192–6.

|| Kohl, F. G., 'Die Transpiration d. Pflanzen, u. ihre Einwirkung auf d. Ausbildung pflanz. Gewebe,' 124 pp. and 4 pls., Braunschweig, 1886. See Bot. Centralbl., xxviii. (1886) p. 292.

the epidermal cells; these cells are elongated in a radial direction, while they lengthen rather in the tangential direction when grown in moist air; in the former case the outer parenchymatous cells of the cortex are usually strongly collenchymatous, only slightly in plants grown in moist air; the bast-fibre-bundles and xylem-portions are more strongly developed, the vessels especially being larger, and having thicker walls. The conditions of transpiration not only affect the quantity of different tissue, but cause the actual formation or disappearance of tissues. Plants grown in moist air have usually longer internodes and leaf-stalks, less indented leaves, and less hairiness.

The author maintains that the transpiration-current takes place in the cavities, and not in the membrane of the xylem-elements.

Chlorovaporization.* — M. P. Van Tieghem calls attention to the difference between the process which he calls by this name, and transpiration. The latter is a function of all living beings, and of all parts of plants whether containing chlorophyll or not, and takes place in darkness as well as in light, though it is promoted both by light and by a high temperature. Chlorovaporization, on the other hand, is a function belonging exclusively to chlorophyll, taking place only from the chloroleucites, and only under the influence of rays of light of a certain refrangibility. It is, in fact, a purely physical phenomenon independent of vital energy, and is much more nearly allied to the assimilation of carbon than to true transpiration; it is probable that, like assimilation, it would be completely arrested by the action of anæsthetics, while transpiration is not suspended by them.

Influence of Cold on the Movements of the Sap.†—By the use of the manometer, especially in the case of the sycamore tree, M. Leclerc du Sablon has established that during periods of frost, whenever a higher temperature thaws the sap, the pressure is unusually great, but varies greatly in different parts of the tree. During days of thaw, the pressure becomes very strong towards the middle of each day, decreasing then rapidly towards evening. On days when the temperature is more uniform, either warm or very cold, the pressure is also more uniform. If the stem is wounded under these conditions, the sap escapes in abundance.

The explanation usually given to the similar phenomenon of weeping, viz. root-pressure, or the endosmotic force in roots, hardly appears to serve in this case.

(7) Chemical Processes (including Fermentation).

Inversion of Sugar by Pollen-grains.‡—M. P. Van Tieghem shows, by renewed experiments, in the cases of the pollen of the crocus, hyacinth, narcissus, wallflower, and violet, the power of converting sugar into inverted sugar. This inversion exists ready formed in ripe pollen-grains. The same result, though in a feebler degree, is produced by the spores of *Lycopodium*, and of some ferns. The quantity of invertin present in some pollen-grains must be very considerable, judging by the small amount of pollen required to produce a considerable quantity of glucose.

γ. General.

Symbiotic Formations.§—Herr A. N. Lundström distinguishes between such examples of symbiosis as are antagonistic (cecidia), and such as are

* Bull. Soc. Bot. France, viii. (1886) pp. 152–5. † Ibid., pp. 208–11.
‡ Ibid., pp. 216–8.
§ SB. Naturvet. Studentsällsk. Upsala, Sept. 28, 1886. See Bot. Centralbl., xxviii. (1886) p. 282.

mutual (domatia). The former are again divided into zoocecidia, produced by animals, and phytocecidia, caused by the attacks of plants. The last again include mycocecidia, due to the attacks of fungi, such as *Synchytrium*, and phycocecidia, e. g. the cephalodia of lichens. Domatia, again, may be zoodomatia or phytodomatia; among the former are the peculiar formations on myrmecophilous plants, and acarodomatia, structures which serve for the habitation of acari. Examples of mycodomatia occur in the swellings on the roots of Leguminosæ, and of phycodomatia in the hollows in the leaves of *Azolla*.

Phytoptocecidia.*—Herr F. Löw describes eleven new galls produced by parasitic fungi on *Achillea nana*, *Anchusa officinalis*, *Galium infestum*, *G. lucidum*, *Gentiana rhætica*, *Lycium europæum*, *Rubus Gremlii*, *Sedum album*, *Sempervivum hirtum*, *Seseli hippomarathrum*, and *Vitex agnus-castus*.

Parasitism of Heterodera javanica.†—Herr M. Treub has detected on the roots of the sugar-cane a new species of nematode, to which he gives the above name, and which is nearly allied to *H. radicicola*, but distinguished by its smaller size. Each gall usually contained several (female) nematodes. Near the head of the parasite were always observed some large cells containing a large number of nuclei. A similar hypertrophic effect has been observed in other cases as the result of the attacks of parasites.

Diseased Potato.‡—M. J. B. Schnetzler describes a potato of abnormal form, 15 cm. long; on its surface were four tubercules, each having a diameter of five to six cm. After having been laid in a cabinet all the winter, a white mould developed on its under surface, which was recognized as *Phytophthora infestans*. On making a section of one of the tubercules, the tissue was found to be overrun with the mycelium of *Phytophthora*, together with a quantity of *Fusisporium Solani*. In the buds a colouring matter, anthocyan, was found, behaving exactly like litmus with acids and alkalies.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Leaf-stalk of Ferns.§—Herr K. Thomae has made an exhaustive examination of the leaf-stalk of ferns; in reference, firstly, to the various points of structure, viz. the epidermal tissue, the mechanical tissue, the receptacles for secretions, the aerating system, the fundamental parenchyma, and the vascular bundles; and secondly, to the different groups into which the order is divided, viz.:—(1) Marattiaceæ; (2) Osmundaceæ; (3) Cyatheaceæ; (4) Polypodiaceæ, with its subdivisions; (5) Gleicheniaceæ; (6) Schizæaceæ; and (7) Hymenophyllaceæ.

One main result is to bring into prominence the differences between the Marattiaceæ on the one hand, and all the other families of ferns on the other hand. In the latter there are no medullary vascular bundles; all lie, in transverse section, on a single curve, which often, in its windings, approaches the centre of the stalk. Those bundles, on the other hand, in the Marattiaceæ which lie within the peripheral circle may be correctly termed medullary. In the composition of the tissues there are also important differences between the Marattiaceæ and true ferns.

* Verhandl. Zool.-Bot. Gesell. Wien, xxxv. (1885) pp. 451–70.

† Ann. Jard. Bot. Buitenzorg, vi. (1886) pp. 93–6 (1 pl.). See Bot. Centralbl., xxviii. (1886) p. 269.

‡ Bull. Soc. Vaud., xxii. (1886) pp. 143–4.

§ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 99–161 (4 pls.).

As regards any system of classification derived from anatomical characters, the separate families show in general a characteristic structure, and this is sometimes also the case with individual genera; but a general classification of all ferns cannot be established in this way. The author considers also that the examination of the leaf-stalk cannot be employed for purposes of classification in palæontology, since it is usually only a fragment that can be examined, with respect to which it is unknown to what height in the stalk it belonged.

Paleæ of Ferns.* —Herr E. Goebeler describes the mode of development and structure of the trichomes of ferns. They originate from older segments of the apical cell of the stem, in which longitudinal, transverse, and tangential septa have already been formed. Subsequently they may develope either into a filament of cells constituting an ordinary hair, or more commonly, by longitudinal divisions into a flat plate of cells, a wedge-shaped apiculate palea or ramentum, the base occasionally remaining unicellular. In some cases there is a central row of elongated cells, a rudimentary mid-rib, which may even divide, by septa parallel to the surface, into several rows of cells from which branches occasionally proceed; in *Asplenium Trichomanes* the mid-rib is especially well developed. The margin of the palea is very commonly glandular or serrate; much more rarely is there a terminal gland. Only after the cells of the trichome have attained their full development do their walls become brown and thickened. Drops of oil and starch-grains are frequently found in the protoplasm of the cells, but never chlorophyll; in *Struthiopteris germanica* there are numerous crystals of calcium oxalate.

In the young frond the paleæ form a close felt, completely concealing it, and forming a protection against mechanical injury, too much moisture, and changes in temperature. They also especially serve as a reservoir of moisture in the case of a large number of ferns which grow in dry situations or as epiphytes; the tannin which they contain greatly assisting in this.

Pilularia.†—Mr. J. G. Baker completes his monograph of the Rhizocarpeæ with a description of the six known species of *Pilularia*, the most important distinguishing character being the number of cells into which the conceptacle is divided.

Muscineæ.

Reproductive Organs of Muscineæ.‡—Herr S. O. Lindberg gives a *résumé* of the important points in the structure of these organs in Musci and Hepaticæ, viz. the inflorescence male and female, the archegonia, antheridia and antherozoids, the calyptra, and the sporophore, composed of the calceolus, which, buried in the disc of the inflorescence, serves to fix the sporophore, and to absorb the nutriment required by the sexual plant, and the capsule or theca with its spores.

Peristome of Bryum.§—In the present portion of his 'Études sur le péristome' M. Philibert treats of those species of the section Cladodium of *Bryum*, in which the ventral plates of the teeth show a tendency to divide, by a larger or smaller number of accessory septa. These seem to form a natural section, divided into two groups; in the first the peristome precisely resembles that of *B. pendulum*, the greater number of the ventral

* Flora, lxix. (1886) pp. 451–61, 476–81, 483–97 (1 pl.).
† Journ. of Bot., xxiv. (1886) pp. 381–2. See this Journal, 1886, p. 1020.
‡ Rev. Bryol., xiii. (1886) pp. 87–94, 100–9.
§ Ibid., pp. 17–27, 81–6; xiv. (1887) pp. 9–11.

plates being divided into several well-marked compartments. To this group belong *B. pendulum*, *Warneum*, and *Brownii* (not *B. Lorentzii*, as the author had previously believed); also *B. Moei* Sch. and *B. Kaurini* sp. n., intermediate between the two latter.

The second group is that of *B. arcticum*, under which species are included a great number of subordinate forms; it is characterized by the ventral plates of the peristome being divided by a single median septum. In this group the author described at length *B. purpureum* sp. n., *viride* sp. n., *inflatum* sp. n., *helveticum* sp. n. A new species resembling this group in the structure of the peristome, but differing in other characters, is described under the name *B. œlandicum*.

Optical Properties of the Peristome of Mosses.*—If the peristome of *Brachythecium rutabulum* is examined under the Microscope with polarized light, M. J. Amann states that the teeth of the exostome will strongly rotate the plane of polarization, and will become illuminated if seen with crossed nicols. The endostome, on the contrary, does not possess this property. If the peristome of a *Barbula* be examined it will be found to be inactive. This action of the peristome on polarized light varies with the genus; it is feeble in *Pottia* and *Weissia*, rather more active in *Grimmia*, more so in *Dicranum*, and considerably more so in *Mnium* and *Hypnum*. The maximum of activity is observed in *Brachythecium*, *Camptothecium*, &c.

If a tooth from the exostome of *Camptothecium lutescens* be examined with a power of about 500 diameters, it will be seen that it is not the whole surface of the tooth that is illuminated, but that there are bands strongly illuminated alternating with those less so.

The author has found that a curious relation exists between the presence of tannin and the optical properties; those organs which contain the largest percentage of tannin being the most active towards polarized light.

Amblystegium.†—M. R. du Buysson describes thirteen European species of this genus of mosses, and details the characters which distinguish it from *Eurhynchium*, *Brachythecium*, *Plagiothecium*, and the different sections of *Hypnum*.

Insectivorous Hepaticæ.‡—In his monograph of *Physiotium* Herr J. B. Jack describes the arrangement of several tropical species (e. g. *P. cochleariforme* and *giganteum*) for capturing and feeding on insects. The "trap" consists of a sac attached to the base of the ventral edge of some of the leaves. In this sac is a fold which is pierced by an orifice. The inner mouth of this orifice is protected by two small leaves, which effectually prevent any small animals that have entered from passing out again. The bodies of great quantities of insects and crustacea were always found in the cavity thus closed; but the author was quite unable to detect any organ or apparatus for their digestion.

Mastigobryum.§—Herr F. Stephani gives a monograph of this genus of Hepaticæ, with descriptions of several new species. He then enumerates all the known species of the genus, 169 in number, of which 41 are described for the first time. The sexual organs of a large number of the species being unknown, they are necessarily classified from vegetative characters, and he proposes the following 11 classes, viz.:—1, Integrifolia;

* Bull. Soc. Vaud., xxii. (1886) pp. 157–61.

† Buysson, R. du, 'Études sur les caractères du genre Amblystegium,' 1885. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 162.

‡ Jack, J. B., 'Monograph of Physiotium.' See F. Stephani in Rev. Bryol., xiii. (1886) pp. 97–9 (1 pl.). Cf. this Journal, 1886, p. 830.

§ Hedwigia, xxv. (1886) pp. 233–49 (2 pls.).

2, Bidentata; 3, Inæquilatera; 4, Connata; 5, Vittata; 6, Parvistipula; 7, Serrulata; 8, Appendiculata; 9, Fissistipula; 10, Cordistipula; and 11, Grandistipula.

Rabenhorst's 'Cryptogamic Flora of Germany' (Musci).—In parts 4–6 of this work Herr K. G. Limpricht completes the Cleistocarpæ, a new genus *Aschisma* being founded on *Phascum carniolicum*. The second division of the Bryineæ, viz. the Stegocarpæ, is then commenced, the first section of it only, the Acrocarpæ, being at present reached. This section he divides into thirty-eight families, an analytical key of which is given. In the family Weissiaceæ, a new genus *Molendoa* is also formed out of *Anœctangium Hornschuchianum* and *Sendtnerianum*, a new species *M. tenuinervis* being also described. The illustrations are numerous and excellent.

Characeæ.

Rotation in Nitella.*—Mr. W. Whiteleggge describes a species of *Nitella* found in the Paramatta River, Australia, in which some of the internodal cells measured from 7 to 8½ in. in length, probably larger than those of any hitherto recorded. The rotation exhibited in the inner nodal cells differs from that of the stems and leaves, inasmuch as the chlorophyll-granules take part in the general rotation. The protoplasm in the young leaves, when viewed under the Microscope with the edge of the cell in focus, appears as a series of elevations and depressions; and with the higher part of the cell in focus these elevations appear as clear spaces surrounded by small granules. Within the layer of protoplasm there exist large numbers of spherical clusters of needle-like crystals, which circulate along the line of demarcation between the cell-sap and the protoplasm.

Algæ.

Formation of Cysts in the Chlorosporeæ.†—M. F. Gay proposes the general term *cyst* for all cells of non-sexual origin in the green algæ which reproduce the plant by remaining dormant for a period and then germinating (Dauersporen, Ruhesporen, spores durables, spores dormantes, resting-spores, hypnospores, chronospores, aplanospores, akinetes, of various authors). They may be formed in two ways, exogenously by the thickening of the cell-wall and gelification of its outer layers, or endogenously by the contraction of the protoplasmic contents, which then surrounds itself with a new membrane of its own.

In the Conjugatæ the formation of cysts has been observed, especially in species of *Zygnema* growing in dry situations; the filaments break up into fragments and become inclosed in a mucilaginous sheath produced by the gelifying of the outer layers of the cell-wall. Cysts formed under these conditions may preserve their vitality for months. When moisture again penetrates the sheath the dormant cells divide by septa and develope into new filaments.

In the Protococcoideæ M. Gay has observed the formation of exogenous cysts in a species of *Tetraspora* and in one of *Chlamydomonas*. In *T. gelatinosa* they result from the encysting of zoospores. A similar process takes place in *Ulothrix tenerrima* and in *Microspora tenerrima*, with the exception that, in the latter case, no gelification was observed of the outer layers of the cell-wall.

In *Stigeoclonium* the cysts are formed by the contraction of the contents of the mother-cell, which then divide into two or four spores, or, in the

* Proc. Linn. Soc. N. S. Wales, i. (1886) p. 476.

† Bull. Soc. Bot. France, viii. (1886) Sess. Extraord., pp. li.–lx.

case of *S. tenue*, without any such division. In *Draparnaldia glomerata β biformis*, and in *Chætophora tuberculosa*, the cysts are formed either in the ordinary way within the cell, or the contents escape and clothe themselves with a new cell-wall outside the mother-cell; in the former species the cysts produced in this way form moniliform rows of cells attached to the thallus.

The cysts may either remain green during their period of dormancy, or may become deeply coloured by an orange pigment; the former is the case especially where desiccation has not been complete.

Tannin in Algæ.*—M. E. De Wildeman has investigated the occurrence of tannin in fresh-water algæ. All the algæ examined, except the Nostocaceæ and Batrachospermeæ, whether floating on the surface of the water or fixed to the bottom or terrestrial, whether affecting marshes or calcareous waters, were found to contain larger or smaller quantities. M. Wildeman regards the tannin as not a mere product of excretion, but as performing an active function in assisting assimilation. The best test for its presence, at least in algæ, is the reaction with salts of iron.

Morphology of Polysiphonia.†—M. K. Rosenvinge describes the mode of formation of the tetraspores, antheridia, and cystocarps, in several species of *Polysiphonia*. The two latter organs he regards as leaves or modified parts of leaves. The mode of branching and leaf-divergence are also described. In *P. fastigiata* peculiar annular formations occupy the intercellular spaces between the central cell and the pericentral cell.

Epiclemmydia lusitanica, a new species of Alga.‡—Mr. M. C. Potter has investigated the life-history of a new species of alga, now named *Epiclemmydia lusitanica*, which lives on the backs of the tortoises inhabiting the pools of Southern Europe. This alga, which to the naked eye appears as small green roundish patches, is found to consist of a number of cells closely applied to the tortoise-shell, but which are only a few layers deep, here and there penetrating into the shell and causing it to flake off. The cells next to the shell always force their way into any available crack, where they divide, and thus penetrate to some depth. The alga is reproduced by means of zoospores formed in the external layer of cells. These zoospores are all exactly similar, and swim about for a considerable time, after which they come to rest, and germinate.

Arctic Algæ.§—Prof. W. G. Farlow publishes a descriptive list of Arctic algæ, collected chiefly in Ungava Bay. It is distinguished by the large number of Florideæ, rare in Arctic latitudes. Among the material collected by L. Kumlien he describes twenty-two species of Florideæ, thirteen of Phæosporeæ, and five of Chlorosporeæ.

Phycotheca Italiana.—The first fascicle of this publication by Signori G. B. Toni and D. Levi has appeared, comprising fifty species of algæ, marine and fresh-water, all from the Venetian territory.

Scandinavian Algæ.‖—M. G. Lagerheim describes seventy interesting species or varieties of algæ gathered in Sweden, including eighteen new species, chiefly desmids and Cyanophyceæ. Among the species described and figured is a new *Oocystis*, *O. submarina*.

* CR. Soc. R. Bot. Belg., 1886, pp. 132-43. Cf. this Journal, 1884, p. 832.
† Bot. Tidsskr., xiv. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 149.
‡ Proc. Cambridge Phil. Soc., Nov. 8, 1886. See Nature, xxxv. (1887) p. 214.
§ Proc. Amer. Acad. Arts and Sci., 1886, pp. 469–77.
‖ Bot. Notiser, 1886, pp. 44–50. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 158.

American Desmids.*—M. G. Lagerheim states the number of species of Desmidieæ at present known in the New World at about 600; the American flora is distinguished by the large number of species of *Pleurotænium* and *Arthrodesmus*, and by one genus, *Phymatodocis*, not yet found in Europe. Many of the American desmids belonging to the genera *Cosmarium*, *Arthrodesmus*, and *Xanthidium*, have remarkable thickened membranes, more or less yellow, and pitted along the median furrow.

Pyritized Diatoms.†—Dr. A. A. Julien states, with regard to "pyritized diatoms," that the material referred to by all writers under the broad name of pyrites, consists substantially of the single mineral pyrite. To determine this point, he searched for minute cavities in which the substance might have found opportunity to crystallize, and discovered not only minute drusy surfaces, but also little spherules covered by projecting crystals. The globules which Mr. Kitton detected appear to have been round and smooth, probably concretionary. On those which he discovered may be seen triangular faces, which appear to belong to octohedra; these crystals must therefore consist of pyrite. This conclusion is confirmed by a specimen of fossil fruit converted into pyrites from the London clay at the Isle of Sheppey. This drusy surface shows distinct sharp octohedra of larger size, so that this crystalline form probably prevails in the pyrite crystals throughout the London clay. The true colour of the pyrite films, when examined on a fresh cross fracture, appears to be a greyish-white. This indicates that the crystals are far from pure, probably mixed with a large proportion of marcasite. The incipient decomposition of the mineral is characteristic of the presence of marcasite, beginning with a golden-yellow tarnish within, and assuming a bronze colour without. As the decay progresses, the valves become covered by a reddish film of iron oxide, and finally the entire material passes into reddish-brown iron-ochre, sometimes blackened as if by the intermixture of oxide of manganese. The mode of deep subterranean decomposition is, therefore, hepatic, and vitriolescence is never observed in these altered diatoms; although the latter form of decay attacks the nodules of pyrites lying nearer the surface in the London clay, at other points along the Thames, as at the Isle of Sheppey.

Lichenes.

Receptacles for reserve-materials in Lichens.‡—Herr H. Zukal finds in the hyphal system of some lichens, especially on the under side, rows or clusters of swollen spheroidal cells which may attain a diameter of 15 μ. They are most abundant in species of *Verrucaria*, but are by no means invariably present in them, and occur also in other genera. By the application of micro-chemical tests, they were found to contain a fatty oil, and the author suggests that they serve as reservoirs of food-material for the formation of fructification.

Fungi.

Endogenous Production of Spores.§—Pursuing his investigations on the mode of production of the spores of fungi, M. J. de Seynes states that a considerable number which are usually described as exogenous are in

* Oefver. K. Vetensk. Akad. Förh. Stockholm, 1885, pp. 225–55. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 159.

† Journ. New York Micr. Soc., ii. (1886) pp. 85–96.

‡ Bot. Ztg., xliv. (1886) pp. 761–70 (2 figs.).

§ De Seynes, J., 'De la production des corps reproducteurs appelés acrospores,' 51 pp. and 3 pls., Paris, 1886. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 145. Cf. this Journal, 1886, p. 832.

reality complex bodies resulting from a union of the wall of the spore with the wall of the mother-cell; and this may probably be the case with the Basidiomycetes. In *Peziza cupressina* the ascospores are formed in this way, and not by free-cell-formation; the ascus with its spores forms a necklace-like kind of structure which ultimately breaks up into joints. The same is the case with the chlamydospores of the Mucorini and in *Mycoderma vini*. The two types of spore, free and united in growth to the wall of the mother-cell, may even be found in the same individual; as in *Sporochisma paradoxum*, the former in the lower, the latter in the upper part of a filament.

In *Ptychogaster albus* and *Polyporus sulfureus* we find terminal spores which are apparently acrogenous, but really endogenous; while those of the sporangioles of *Chætocladium* and *Piptocephalis* are truly endogenous. In the formation of the conidia of *Aspergillus candidus* the protoplasm may be seen to accumulate at several points of the filament, and each spore clothes itself with a membrane intimately fused with that of the mother-cell; the spores finally presenting the appearance of a necklace. The same is the case in *Penicillium glaucum*. In *Psilonia cuneiformis* the spores are of endogenous origin, and the filament continues to grow after they have fallen to the ground.

Formation of Starch in Sclerotia.*—M. E. Belzung has investigated the mode of formation of the starch in the sclerotia of *Claviceps purpurea* and *Coprinus stercorarius*, and finds that it is different from that which takes place in the endosperm of the castor-oil plant, where there is no fresh formation of leucites during germination, the starch being produced entirely in the pre-existing leucites. Fungi, on the contrary, are capable of producing true starch-grains. In the sclerotia named, the cell-contents consist entirely of leucites in the form of a very fine granulation; and it is in these leucites that the abundant starch is formed.

Helicobasidium and Exobasidium.†—From further examination of the mature fructification of *Helicobasidium purpureum*, parasitic on *Asarum europæum*, M. N. Patouillard maintains his view that the genus must be kept distinct from *Exobasidium*. He also dissents from the proposal to place its species as a subgenus of *Corticium*.

Conidial Form of Hymenomycetes.‡—M. N. Patouillard describes a new fungus to which he gives the name *Ptychogaster aurantiacus*, the inner portion of which is composed of hyphæ mingled with large spores, 12–14 μ by 5–6 μ, the medium portion having, on the contrary, spores formed at the extremities of the filaments. The spores are formed by the filament swelling at its apex, where the protoplasm accumulates, and becomes separated by a septum. It is probably the conidial state of a Polyporea allied to *Trametes*.

Macrophoma, a new genus of Sphæropsideæ.§—Under the name *Macrophoma* Berl. and Vogl, Sig. A. N. Berlese proposes a new genus containing no fewer than 99 species removed from the genera *Phoma*, *Sphæropsis*, and *Sphæronema*. The following are its characters:—Perithecia subcutanea, dein erumpentia membranacea subcoriacea et subcarbonacea globosa glabra erostrata, ostiolo minuto subinde obsoleto. Sporulæ ovoideæ fusoideæ v. cylindraceæ majusculæ v. magnæ, 15 amplius μ longæ sæpe granulosæ continuæ hyalinæ, rarissime biguttatæ. Basidia filiformia subinde brevissima v. obsoleta, constanter simplicia.

* Bull. Soc. Bot. France, viii. (1886) pp. 198–202.
† Ibid., pp. 335–7. Cf. this Journal, 1885, p. 1045.
‡ Rev. Mycol., 1885, p. 28 (3 figs.).
§ Atti Soc. Ven.-Trent. Sci. Nat., x. (1886) pp. 176–205 (2 pls.).

Conjugation of Mucorini.* — M. P. Vuillemin describes a peculiar mode of conjugation, or, as he prefers to term it, anastomosis, in a hitherto undescribed species of *Mucor*, which he calls *M. heterogamus*. This process, which results in the production of the zygospore, consists, in this species, of the union of two very unequal elements proceeding from branches as dissimilar as possible. The first stage is the appearance of a transverse septum near the apex of the principal filament or of one of its branches. The apical segment thus formed increases rapidly in length, but remains slender, and contains a comparatively small amount of protoplasm. Below it the protoplasm accumulates, and forms a lateral bud. The extremity of this protuberance swells and curves, while opposite to this swelling the slender filament puts out a lateral emergence. These two gametes, very unequal in size, conjugate, and each becomes separated from its parent filament by a septum; the membrane which divides them disappears, as also does the beak which constitutes the smaller gamete.

The zygospore thus formed, has, when mature, a thin internal membrane furnished with simple points, and an external brown coat with black almost confluent plates. Instead of the single lateral swelling, there are sometimes two, which conjugate with the small protuberances from the single slender filament.

Membrane of the Zygospores of Mucorini.†—M. P. Vuillemin has traced the history of development of the wall of the zygospores in *Mucor heterogamus* (*vide supra*), and in some other species of Mucorini. He does not admit two distinct membranes of different origin, as in the oosphere of Peronosporeæ, but only one, with centripetal growth, which becomes ultimately differentiated into five distinct zones. While admitting that these two organs are possibly of similar origin, he regards the zygospore of the Mucorini as probably not of a sexual nature, but as an asexual spore preceded in its formation by the simple anastomosing of vegetative branches.

Development of Pyrenomycetes.‡—Herr F. von Tavel has followed the history of development of some of the numerous kinds of parasitic fungi found on plane-leaves.

Of *Glœosporium nervisequum* Sacc., which is very destructive to young trees, he was unable to discover either the perithecia or pycnidia; from the gonidia was developed only a similar conidial form.

Discula Platani Sacc. must be regarded, from its history of development, as a pycnidium, although differing in some points from the usual structure. Its further development, however, the author was unable to follow. Leaves of the plane-tree were infected by it without result. It is always found in close proximity to the *Glœosporium*, and may possibly be a stage in its cycle of development.

Growing out from a *Cytispora* was a new form, which v. Tavel describes as *Fenestella Platani*. The basidia are unbranched, and produce enormous numbers of unicellular spores. The asci contain eight spores, which are septated, when mature, by three septa. Agreeing in general characters with the genus *Fenestella*, it differs from the species hitherto known in the small number of septa to the spores, and in the unusual development of the neck. From its ascopores is developed a conidiiferous mycelium belonging to the form *Acrostalagmus*. A genetic connection between this and the pycnidial form, though probable, the author was unable actually to determine.

* Bull. Soc. Bot. France, viii. (1886) pp. 236–8. † Ibid., pp. 330–4.
‡ Bot. Ztg., xliv. (1886) pp. 825–33, 841–6, 857–67, 873–8 (1 pl.).

A species of *Cucurbitaria*, which is probably new (*C. Platani?*), was also observed. It appears to be a saprophyte rather than a parasite. Both pycnidia and ascospores were observed.

Protoventuria, a new genus of Pyrenomycetes.*—From the well-known genus *Venturia* De Not., Sig. A. N. Berlese proposes to separate *V. Rosæ* as a distinct genus under the name *Protoventuria* Berl. et Sacc., with the following diagnosis:—Perithecia superficialia majuscula carbonacea fragilia globosa-depressa, vertice setis rigidis aterrimis longiusculis vestita, basi setulis subtilioribus numerosissimis pallidis subtortuosis septatis cincta, poro rotundo amplo pertusa. Asci oblongi v. elliptici, basi abrupte attenuati, in pedunculum brevissimum desinentes, octospori. Paraphyses nullæ v. obsoletæ. Sporidia constricto-didyma bilocularia, loculis subæqualibus saturate fuligineis.

New genera of Pyrenomycetes.†—M. N. Patouillard describes the two following new genera of Pyrenomycetes, both from China.

Cylindrina. Perithecia simple, somewhat horny, erect, cylindrical, truncate, and hollowed at the summit into a cup, in the centre of which is a pore. Thecæ cylindrical, greatly elongated. Spores filiform, continuous. Paraphyses slender, simple, very numerous. Near to *Acrospermum*. *C. Delavayi* was found on dead leaves of *Liparis liliiflora*.

Pyrenotheca. Stroma bearing a large number of close rounded black carbonaceous receptacles, formed of a homogeneous cellular tissue, hollowed in its upper part by a large number of pits arranged irregularly in several rows, and each inclosing a single globular or ovoid sessile theca containing eight colourless ovoid septated muriform spores. Paraphyses 0. Near to *Eurytheca*. *P. yunnanensis*, parasitic on the living bark of a *Buxus*.

Tubercularia.‡—Dr. F. Morini discusses the systematic position of this genus of Fungi, and dissents from the conclusion of Gobi that it belongs to the Ustilagineæ. He regards the mode of sporification as differing essentially from that in *Entyloma*, in the distinct differentiation of a mycelium and fertile hymenium, which does not exist in that genus. The cycle of development of *Tubercularia* is also altogether different from that which occurs in the Ustilagineæ. As regards its true position, Morini thinks that *Tubercularia* shows the greatest affinity with the Tremellini.

Contrary to the view of de Bary, Morini regards the process of anastomosis displayed by the sporidia of many Ustilagineæ as a phenomenon of simple fusion of cells, and as having no sexual character.

Scandinavian Peronosporeæ, Ustilagineæ, and Uredineæ.§—In a detailed account of these parasitic fungi from the lofty mountains of Jämtland and Härjedalen, Herr C. J. Johanson remarks on the comparative abundance of the subgenera *Leptopuccinia* and *Micropuccinia*, distinguished by the absence of the uredo- and æcidial forms. While in Germany the species of these subgenera make up 33 per cent. of the entire genus *Puccinia*, in Italy 30 per cent., and in Holland 25 per cent., in the districts above referred to they amount to 60 per cent. The following new species are described:—*Peronospora alpina* on *Thalictrum alpinum*, *Puccinia rhytismoides* on the same plant; *P.* (*Micropuccinia*) *rubefaciens* on *Galium boreale*, *P.* (*M.*) *scandica* on *Epilobium anagallidifolium*.

* Atti Soc. Ven.-Trent. Sci. Nat., x. (1886) pp. 171–5 (1 pl.).
† Bull. Soc. Bot. France, viii. (1886) pp. 155–6.
‡ Malpighia, i. (1886) pp. 114–24.
§ SB. Naturvet. Studentsällsk. Upsala, Oct. 12, 1886. See Bot. Centralbl., xxviii. (1886) pp. 347 *et seq.*

Ancylisteæ and Chytridiaceæ.*—Dr. W. Zopf describes in detail the structure and life-history of the following fungi parasitic on various species of *Zygnema*, *Mougeotia*, *Spirogyra*, *Cladophora*, diatoms, *Saprolegnia*, and other fresh-water organisms, viz.:—*Lagenidium Rabenhorstii*, *L. entophyllum*, *Myzocytium proliferum*, *M. proliferum* var. *vermiculum* (on nematoid worms), *Olpidiopsis Schenkiana*, *Pleotrachelus fulgens*, *Ectrogella Bacillariacearum*, *Amœbochytrium rhizidioides*, *Hyphocytium infestans* (on a *Peziza*), *Rhizidiomyces apophysatus*, *Rhizidium intestinum* (on *Nitella*), *R. bulligerum*, *R. Cienkowskianum*, *R. Fusus*, *R. carpophilum*, *R. sphærocarpum*, *R. appendiculatum* (on a Palmellacea), *R. apiculatum*, and *R. acuforme*.

Dr. Zopf adopts Pfitzer's classification of the genera *Ancylistes*, *Lagenidium*, and *Myzocytium* into a distinct family under the name Ancylisteæ, distinguished from the rest of the Saprolegniaceæ by the circumstance that the existence of the vegetative organ as such closes with the development of the fructification, the mycelial tube being entirely used up in the formation of the sporangia or of the sexual organs; while in the higher Oosporeæ the mycelium may even continue to develope after the formation of the fructification. The mycelium is in this group always very feebly developed, and in *Myzocytium* is almost entirely suppressed; while in the higher Saprolegniaceæ and Peronosporeæ it attains to the dignity of a copiously branched mycelial system.

A third characteristic of the group is in the mode of formation and escape of the swarmspores, at present known only in *Ancylistes*, and agreeing more with *Pythium* than with *Saprolegnia*. The zoospores are perfectly formed only outside the sporangium, in the vesicle formed by the tumidity of its inner cell-wall. A further distinction from both Saprolegniaceæ and Peronosporeæ consists in the process of impregnation. While in both these groups the oosphere is completely formed before impregnation, in the three genera under discussion this takes place only during and subsequently to that process; and, instead of only a portion of the contents of the antheridium being required for the purpose of impregnation, the whole passes over into the oogonium. Again, while in the Peronosporeæ only a portion, in these genera the whole of the protoplasm of the oogonium is used up in the formation of the oosphere.

These peculiarities of structure are held by Dr. Zopf sufficient to justify the formation of a separate group of Ancylisteæ out of three genera, although the process of impregnation has not yet been observed in *Lagenidium*, and only imperfectly in *Myzocytium*. But the process, as known in *Ancylistes*, forbids the idea of a very close affinity between this group and the Pythieæ; it much more nearly resembles a process of true conjugation than in that family.

While the Ancylisteæ exhibit an affinity upwards with the higher Oosporeæ, they are also connected downwards with the Chytridiaceæ, and especially with certain Olpidieæ. This is well seen in the resemblance between the reduced neutral and sexual individuals of *Myzocytium proliferum* on the one hand, and between the neutral and sexual individuals of *Olpidiopsis Schenkiana* on the other hand. This resemblance is so great, that unicellular sporangial plants of the former species cannot be distinguished from sporangia of the latter, when both are still unripe or already discharged. There is a similar close resemblance between the mycelial tube of *Ectrogella* and that of *Ancylistes*.

On these grounds the author suggests that the Olpidieæ are possibly

* Verhandl. K. Leop. Carol. Deutsch. Akad. Naturforscher, xlvii. (1885) pp. 141–236 (10 pls.).

reduced Ancylisteæ, the reduction being displayed in the disappearance of the antheridial fertilizing tube on the one hand, and in the reduction, on the other hand, of the oogonium to an oosphere, as seen in *Olpidiopsis Schenkiana*. In other Olpidieæ the reduction may be carried out still further to apogamy, or the entire suppression of the antheridia, as possibly in *O. Saprolegniæ*.

Fungi parasitic on Coniferæ.*—Dr. E. Rostrup describes a number of fungi parasitic on different species of conifers in various parts of Denmark.

In one district a peculiar disease was noticed on *Pinus excelsa*, due to the attacks of *Nectria cucurbitula* on the lower part of the stem; the blood-red sporangia forming a perfect ring round the stem.

Pinus balsamea was in many places attacked by *Thelephora laciniaia*, forming great balls.

In one district various species of pine (but not *P. austriaca*) were badly attacked by *Cæoma pinitorquum*. This had been communicated from an aspen on which *Melampsora pinitorquum* was strongly developed.

The author was able to determine, by direct observation, that *Lophodermium Pinastri* is the cause of the disease of *Pinus austriaca*. The ends of the branches lose their colour from the attacks of the mycelium, which then penetrates into the leaves, and ramifies through the whole tree.

New Genus of Chytridineæ.†—M. P. A. Dangeard has observed a parasite endogenous in several Rhizopods and Flagellata, which he regards as the type of a new genus of Chytridineæ, and calls *Sphærita endogena*. It first makes its appearance in the form of single vesicles of hyaline protoplasm within the body of the host, a portion of the surface being finely granular. Gradually the protoplasm becomes denser and finely punctated, and finally breaks up into a number of zoospores with a mulberry-like appearance.

The author considers that the theory of the reproduction of the Flagellata by division of the nucleus, first advanced by Stein, and adopted by Carter and Saville-Kent, rests on an erroneous interpretation of the appearance presented by the germs of parasitic Chytridineæ; and that the so-called endogenous germs described in a large number of species of Euglenеæ may all be referred to *Sphærita endogena*.

In a second paper ‡ M. Dangeard describes a new species of *Chytridium*, *C. helioformis*, parasitic on a *Nitella*, and which he succeeded in cultivating also on *Chara polyacantha* and on a *Vaucheria*. The cysts of this species develope like sporangia, and there is no trace of any sexual reproduction. Cienkowski's *Rhizidium Confervæ-glomeratæ* is regarded by Dangeard as a *Chytridium*.

Structure of Entyloma.§—Prof. H. Marshall Ward has investigated the structure and life-history of *Entyloma Ranunculi*, a parasitic fungus belonging to the Ustilagineæ, found on *Ranunculus Ficaria*. He found the resting-spores and conidia on the same mycelium. The process of germination of the spores was followed out, which had not previously been done in the case of any *Entyloma*. The germinal hyphæ enter the stomata of the host, and produce between the cells of the mesophyll a mycelium on which are borne the resting-spores, thus placing beyond doubt the connection between the two kinds of spore.

* In Danish, 1885. See Bot. Centralbl., xxviii. (1886) p. 105.
† Bull. Soc. Bot. France, viii. (1886) pp. 240–2. ‡ Ibid., pp. 357–8.
§ Proc. Roy. Soc. Lond., xli. (1886) p. 318.

New Synchytrium.*—The *Synchytrium*, parasitic on *Dryas octopetala*, and previously considered by Dr. F. Thomas as a variety of *S. Myosotidis*, he now describes as a distinct species under the name *S.* (*Chrysochytrium*) *cuspidatum*. It is distinguished by the form of the cecidium induced in the host by the parasite, which extends above the epidermis, is at first globular or the form of an elongated sac, and afterwards closes into that of a cup or saucer. It is identical with the variety *Potentillæ* Schœt.

Alcoholic Fermentation on living Trees.†—Dr. F. Ludwig has observed on living oak-trees, as well as less frequently on birches, poplars, and maples, the formation, sometimes in large quantities, of a whitish mucilage with a strong odour of beer, and having great attraction to a number of insects, especially hornets. The fungoid masses which give rise to this mucilage consist of a branching filamentous fungus, forms allied to *Saccharomyces*, and an organism evidently allied to *Leuconostoc*.

The alcoholic fermentation is caused by the filamentous fungus, which clearly belongs to the Gymnoasci, forming the characteristic endospores, and proposed by the author as a new species with the name *Endomyces Ludwigii*. The main filament branches copiously, and both it and the branches break up freely into gonidia, which vary greatly in size. The formation of asci was frequently observed. These are obovate, 25–30 μ long, 18–20 μ broad, and are formed at the end of longer or shorter main or secondary branches. The ascospores are always four in number, and change in colour from pale yellow to yellow-brown; they are set free by the absorption of the ascus. The alcoholic fermentation appears to be caused directly by the formation of the branches of this fungus, although it is then greatly promoted by the formation of the bacteria found in the mucilage. The development of the conidia corresponds very closely to that of *Saccharomyces albicans*.

The mucilage consists mainly of a Schizomycete, to which Dr. Ludwig gives the name *Leuconostoc Lagerheimii*, which forms elongated or spherical colonies, often of very large size, consisting of wavy or coiled chains of cocci or diplococci enclosed in copious gelatin; the cocci have a diameter of about 0·6–0·8 μ. The gelatinous envelope is of much less consistency than that of *L. mesenteroides*. Small spherical colonies of this organism appear to be formed first on the filaments of the *Endomyces*, the cell-walls of which they then completely destroy. Placed on meat-peptone nutrient gelatin, they cause it rapidly to deliquesce.

Protophyta.

Hormogones of Glœotrichia natans Thur.‡—Dr. G. Beck records in this species (*Rivularia angulosa* Roth.) a peculiar mode of formation of hormogones. The lowermost cell becomes a heterocyst, and its contents pass through a pore or through an open communication into the next cell, which becomes the basal cell of a hormogone. The hormogones produced in this way differ from those formed in the ordinary manner in possessing a heterocyst from the first.

Reproduction of Codiolum.§—M. G. Lagerheim confirms the statement of Farlow with respect to another marine species of *Codiolum*, that *C. polyrhizum* is not reproduced by zoospores, but by rounded immotile aplanospores, inclosed in a delicate membrane. These develope directly

* Bot. Centralbl., xxix. (1887) pp. 19–22. † Hedwigia, xxv. (1886) pp. 168–72.
‡ Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvi. (1886) pp. 47–8.
§ Oefvers. K. Vetensk. Akad. Förh. Stockholm, 1885, pp. 21–31. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 158.

into the adult cell, which attains a height of from 90–170 μ. *C. polyrhizum* is found on empty marine shells, which also serve to support *Mastigocoleus testarum.**

Urococcus, Coccochloris, and Polycystis.†—Herr P. Richter describes the life-history of *Urococcus insignis.* In its early stage it has all the appearance of a *Glœocystis*, but is not identical with any known species. The well-known "stalk" is not peculiar to the genus, but belongs also to *Glœocystis* and *Hormotila.* When actively growing *H. insignis* has no stalk, and is then simply inclosed in a larger or smaller number of excentric envelopes, and closely resembles *Chroococcus macrococcus*, with which it may be identical.

The author proposes to restore the old genus *Coccochloris*, which has been merged in *Aphanothece*, and describes *C. stagnina* Spreng., with which he unites *Aphanothece cærulescens* Br.

A remarkable new species, *Polycystis scripta*, is described, forming a sulphur-yellow scum on the surface of salt water; it appears to derive its sustenance from decaying seaweeds.

Pathogenic Bacteria.‡—Herr H. Mittenzweig summarizes the work of German investigators on pathogenic bacteria. He adopts the classification of Koch and Hüppe, founded on their form. After describing the various processes of studying bacteria, he details the observations of German bacteriologists on certain special microbes, such as those of cholera, typhoid fever, gonorrhœa, syphilis, &c., the various properties of these bacteria being described in detail.

Tuberculosis of the Olive.§—M. L. Savastano has investigated the diseases of the olive somewhat indiscriminately known as "maladie de la loupe" and "rogna"; some being caused by hypertrophy of the tissues due to external causes, others by a special bacterium which forms tubercles on the young branches. This bacterium, named by Arcangeli *Bacterium oleæ*, was cultivated on potato and gelatin, but no exact description is given of it.

Tubercle Bacilli.‖—As the result of prolonged investigations, Herr v. Sehrön notes :—(1) the tubercle bacillus is in its young stage a torula-chain; (2) with increased growth the granular elements of the chain become distant, and are united by a band; (3) the intercellular substance of the *Bacillus* is a secretion of these elements, and is formed by apposition; (4) in retrogressive metamorphosis the granules of the torula-chain become free as bacillar spores; (5) these liberated spores grow into mother-spores, which exhibit a capsule and enclosed contents; (6) the finely granular contents of the mother-spores become daughter-spores; (7) the daughter-spores burst the capsules and issue singly or in a torula-chain (young *Bacillus*) from the mother-spore.

* See this Journal, 1886, p. 665.

† Hedwigia, xxv. (1886) pp. 249–55.

‡ Mittenzweig, H., 'Bacterien-Aetiologie der Infections-Krankheiten,' 136 pp., Berlin, 1886. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 177.

§ Comptes Rendus, ciii. (1886) pp. 1144–7.

‖ Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1886) p. 634.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Grunow's Physician's Microscope.†—In this instrument, designed by Mr. J. Grunow (figs. 35 and 36), the whole stand is of brass, with

Fig. 35.

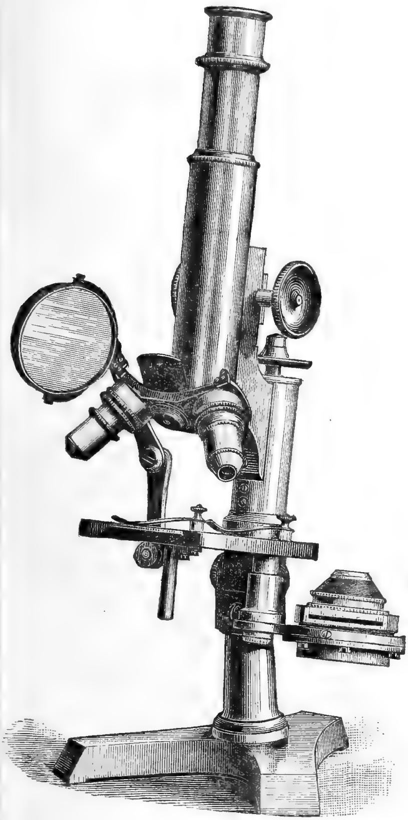
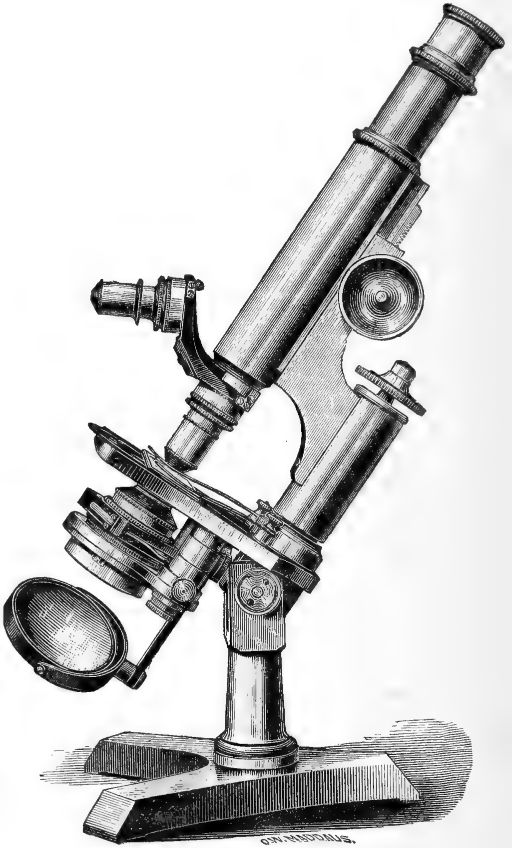


Fig. 36.



rack-and-pinion coarse, and micrometer-screw fine-adjustments. The stand can be inclined to any angle. The mirror is mounted on a double arm, so that it can be swung above the stage for the illumination of opaque objects. The substage is on a pillar attached to the base of the Microscope, and may be turned aside, thus facilitating the exchange of accessories without disturbing the object in the field.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Microscopical Optics and Manipulation; (7) Miscellaneous.

† The Microscope, vi. (1886) p. 245 (1 fig.).

Burch's Perspective Microscope.*—Mr. G. J. Burch, in 1874, while trying to devise means whereby the different planes of an object should be visible under the Microscope without the adjustment of the focus to each, discovered that, when two lenses are separated by a distance equal to the sum of their focal lengths, the optical conditions are such that the magnitude of the image bears a constant ratio to that of the object, no matter where upon the optic axis it is situated—the ratio being that of the focal lengths of the two lenses; that a given displacement of the object along the axis causes a displacement of the image in the same direction, but in the square of the ratio.

Further, that a picture drawn with the camera lucida under these conditions has the perspective of an object magnified in the square of the ratio, when it is brought within the proper distance of the eye.

The field of view of the perspective Microscope is small, but may be increased by using more than two lenses, and the author's researches gave him reason to believe that, with glasses of wide angle specially constructed, a high power, with sufficiently large field, might be obtained. Several uses other than microscopic were indicated, to which the instrument can be applied.

The paper, as read to the Royal Society, was accompanied by diagrams, showing, in two different ways, the changes of position of the principal foci and principal points, &c., of a system of two lenses, as the distance between them is varied, and a piece of moss was shown under the instrument, in magnified perspective.

Entomological Microscope.†—M. J. L. Weyers discusses the proper form, &c., of a Microscope suitable for entomologists, which we read with attention until nearly its conclusion, without clearly appreciating what the author proposed in the way of an improvement upon the existing forms. The last paragraph, however, dispensed with any necessity for again reading the paper to supply the missing clue. That paragraph runs as follows:—"In fine, the compound entomological Microscope requires no novel arrangement; no unknown accessory. It simply aims at uniting in one and the same instrument the different arrangements applied hitherto separately to the usual compound Microscopes."

Lehmann's Crystallization Microscopes.‡—Dr. O. Lehmann has now found it possible to construct a smaller, more portable, and cheaper form of the Microscope, with which his observations on the growth of crystals were made.§

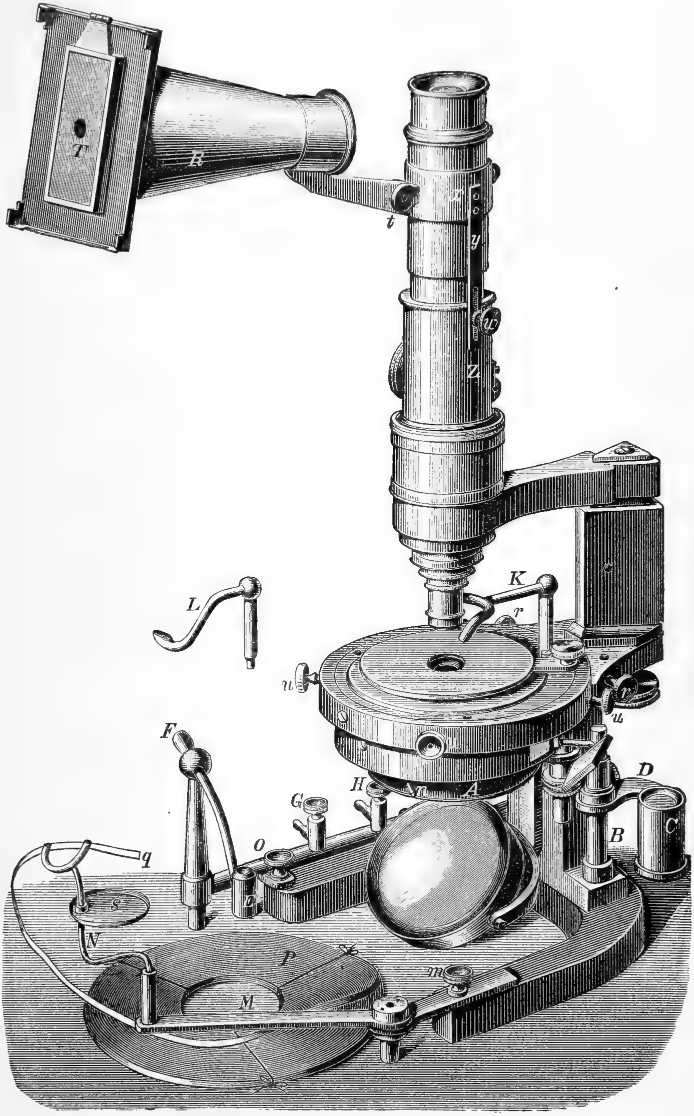
The new instrument, as described by him under the name of the "*Small Crystallization Microscope*," is shown in fig. 37, from which it will be seen that it is not so much a Microscope of special construction (in fact it is a Merz 1866 instrument) as an ordinary instrument adapted by the addition of certain supplementary parts.

The form of the stage is shown in fig. 38; the hollow rotating centre *b* carries the platinum covered stage *a* supported on a cylindrical ring which is pierced with numerous holes to allow the products of combustion to escape as indicated by the arrows, while to its lower side is fixed the graduated circle *c*; *d* is a handle by which the stage is turned, and which abuts against a stop for the zero point of the scale; the tube *e* in which the stage rotates is centered by the four screws *u*; the index is fixed to this

* Nature, xxxv. (1887) p. 358.
† Comptes Rendus Soc. Entomol. Belg., 1886, pp. xc.–iii.
‡ Zeitschr. f. Instrumentenk., vi. (1886) pp. 325–34 (3 figs.).
§ See this Journal, 1885, p. 117.

piece so that it is not disturbed by the centering of the stage, and at *f* is a small aperture through which the observer reads the scale from a vertical position by means of the inclined mirror shown in fig. 37. The rotation of the upper part of the Microscope is confined within very narrow limits by

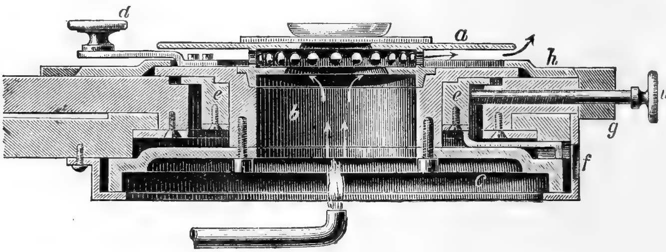
FIG. 37.



the two screws *r r* of fig. 37, and is only employed to bring the index and zero point of the scale into coincidence after centering. The cover *h* and circular band *g* serve as protections for this part of the instrument.

A (fig. 37) is the frame of a diaphragm of the ordinary form, except that the smallest opening has been replaced by a large one, which can be partially closed with a crescent-shaped screen by means of the handle *n*. C is the polarizer attached to the arm D, which slides on and revolves round the column B, so that it can be rapidly introduced and withdrawn while the object is being heated. The heating apparatus consists of the

Fig. 38.

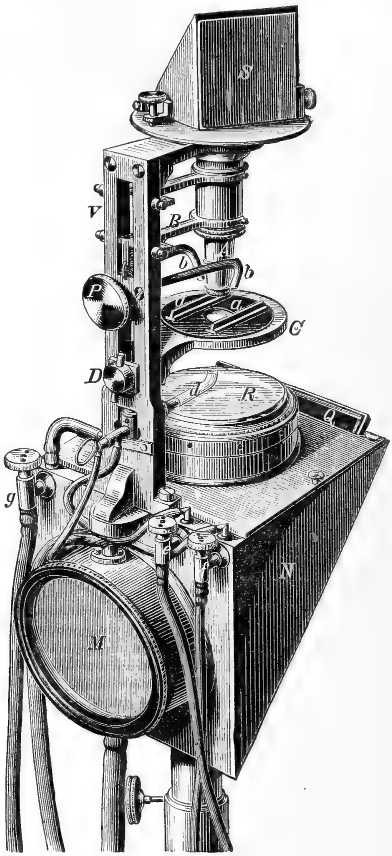


burner E which is supplied with gas and air through the taps G and H; it is fixed to a movable arm, and is adjusted by the handle F, and clamped by two screws, of which one is seen at O; the tube which conveys air is continued inside the gas-tube until it almost reaches the beginning of the arm; the burner is closed at the bottom by a plate of mica, so that the object may be partly illuminated from below through the flame. K is a tube with double orifice which is used for cooling the object by means of a current of air transmitted through a passage in the foot of the instrument and regulated by a screw tap, so that the temperature is completely under control, and may be varied at will. M is a movable arm with stop, which is attached by the screw *m* to the other foot of the instrument and carries a holder N; this serves to support the end of a magnesium band P over the tray *s*, and it is pivoted so that the projecting portion of the band at *q* may be directed towards the mirror; in this way the field remains brilliantly illuminated as the metal burns; the same burner E which is used for heating purposes may be also employed to ignite the wire. The magnesium flame is used for photographing the object, and for this purpose the upper part of the tube Z is provided with a movable ring *x*, to which is attached by the hinge *t* the camera R. The Microscope may then be rapidly converted into a photographic apparatus by swinging R into the vertical position. T is a hinged frame carrying a ground-glass plate by which the image is roughly focused, the final adjustment being made upon a small spot of smooth glass which occupies the centre of the ground-glass plate by means of a lens hinged to T; the camera is clamped in position by the screw *w* which passes through a slot in the bar *y* firmly attached to *x*, and finally the focusing plate is replaced by an aluminium slide containing the sensitive dry plate. The dry plates used are of small size ($6 \cdot 5 \times 9$ cm.), and may be developed and fixed by the light of a petroleum or gas lamp with red chimney.

In place of K the tube L (shown at the side of the figure) may be mounted on the stage; this tube is used to direct a current of air upon the objective, so as to protect the lenses against the heat of the stage and to carry away the products of combustion which would otherwise condense upon them; if a greater degree of cold is required, this current of air may be first passed through a freezing mixture and drying tube.

The chief object which this instrument seeks to attain is the rapid change of certain parts; the heating apparatus, the magnesium-light, the camera, the cooling apparatus, and the polarizer, are all so constructed that they may be introduced and withdrawn without loss of time, since the operations have to be conducted with great rapidity during the growth of the crystals. The author suggests other additions and improvements which might be made; for instance, a water cooling-apparatus for fusion experiments; a roll of sensitive paper to be used for a continuous series of photographs in place of a set of dry plates, &c., and promises an account of observations which he has recently made with the Microscope upon bodies under high pressures, in small capillaries, and in vacuum.

Fig. 39.



The *Crystallization Microscope for projection* is shown in fig. 39. A is the objective which is adjusted by a parallelogram movement B by means of the screw P. The stage C is movable along a vertical slot in the upright V, and is clamped by the screw D. The object lies upon the two edges *a*, which allow a free passage of the air, and *b b* are as before the two tubes by which the object is cooled; *d* is a glass burner which receives its supply of gas and air through the two screw-taps *e* and *f*; the current of air in *b* being regulated by the screw-tap *g*.

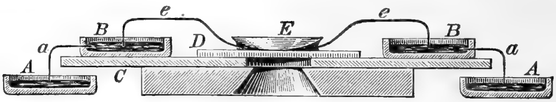
The light from an electric lamp enters the apparatus at M through two parallel plates of glass through which circulates a current of water free from lime, such as rain-water; ordinary water soon leaves a deposit of carbonate of lime upon the glass, and cannot be used for the purpose. N is a water-tight chamber filled with concentrated solution of alum containing also a few loose crystals of alum, which are dissolved when the temperature rises; the hypothenuse of this triangular chamber is occupied by the plane mirror Q, which reflects the light upwards through the plano-convex condensing lens R of short focal length, which illuminates the object with a convergent beam of light from the electric lamp. After the rays have traversed the objective they enter a rectangular prism S, by which they are reflected in a horizontal direction and throw an image upon the screen; the prism S being adjusted by means of a screw and hinge.

This instrument may conveniently be used not only for demonstration, but also for photographing, by allowing the rays to enter an ordinary

camera from which the objective has been removed; and the author suggests its employment to demonstrate the phenomena of electrolysis (fig. 40).

A A are mercury connections which receive the wires from a battery of six small Grove's cells; a rheostat, contact-breaker, and commutator being included in the circuit. The current is conveyed from A A by *a a* to B B, two

FIG. 40.



vessels of mercury, which are insulated and fixed upon C a plate with a hole in its centre, which rests upon the stage. D is the object-carrier, on which a drop of the solution is placed, being then covered with a flat watch-glass E, having its convex side downwards; the electrodes are formed by the wires *e e*, terminating in arrow-shaped platinum points, which are brought into contact with the drop. Any desired movement is given to the object by the motion, not of D, but of the plate C. The mercury connections obviate the pressure or elasticity which would be introduced by solid connections.

Nelson's "New Student's Microscope."—Mr. E. M. Nelson claims * that this instrument "begins a new era in the progress of 'microscopy,'" and that for the "first time in the history of the Microscope a thoroughly sound full-sized instrument" can be supplied at the same price as a student's Microscope.

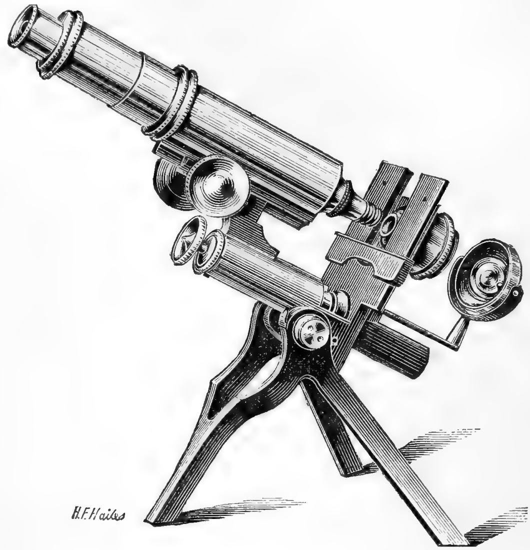
Referring to some of the points adopted in this new Microscope—points where there must of necessity be much that is old in design—Mr. Nelson divides Microscope feet into four classes:—1st. The simple tripod, illustrated by the Powell form. 2nd. The plate and uprights. A flat plate with pillar or pillars, as in the Beck model; and a plate with flat uprights, as in the Andrew Ross. 3rd. The bent claw, a very common and bad form, used by many makers. 4th. The heavy horseshoe, the usual Continental model. The plate and uprights, though a good form, was not adopted because it was too heavy and expensive. The bent claw is a bad form: it is heavy, easily capsized, and while seemingly a tripod, often rocks on four points. The heavy horseshoe which, until lately, was always fitted to students' Microscopes, has nothing to recommend it. A designer, Mr. Nelson considers, "must indeed be hard up for resources who can only obtain steadiness by weight. There can be no question but that the tripod in its simplest form is the best. Of all the ways of utilizing it, that adopted by Messrs. Powell and Lealand is the most efficient, viz. of hanging the Microscope in a horseshoe, supported by three legs; but that for this class of instrument was quite out of the question, for cost immediately puts it outside the category of students' Microscopes.

There is a great difference between the steadiness of a Microscope perched up on the top of its trunnions, and one that is hung in a tripod. The new Microscope (fig. 41) is placed in a kind of stirrup hanging from the trunnions. . . . The body is large enough to take Zeiss's full-sized eyepiece, viz. $1\frac{3}{8}$ in., and is 10 in. long when the draw-tube is pulled out to a mark. When the draw-tube is pushed home, the length is 6·3 in., or Continental gauge. It, therefore, will suit both kinds of apochromatics. The optic axis of the instrument, when in a horizontal position, is $8\frac{1}{2}$ in. from the table. It has rackwork coarse-adjustment, and Campbell's fine-

* Cf. Eng. Mech., xliv. (1887) p. 497.

adjustment. It is to this fine-adjustment that the instrument owes its origin. The moment Mr. Campbell explained to me the principle of his fine-adjustment, I foresaw the construction of an efficient student's Microscope. The direct-acting screw is only suitable for low powers and small apertures. I will put it even stronger: delicate work with high powers and wide apertures is not possible with any Microscope having a direct-acting screw fine-adjustment.

Fig. 41.



The stage is of the cut horseshoe form. . . . The principal object of it is to enable you to feel your working distance. Let me point out a great improvement in the sliding bar. Its guiding lugs are stowed away underneath the stage; I have no hesitation in saying that next to a perfect mechanical stage this is the best. Most of the mechanical stages are so defective in design, and so scamped in their workmanship, as to be worse than useless.

The substage is fitted with a tube, having a spiral slot for focusing. . . . There is a novel feature about the stops for dark-ground illumination, viz. there is a three-legged carrier which holds them all. This carrier has a pin in the centre of it on which the various sized discs fit. The stops, diaphragms, &c., have a separate tube-fitting for them, so that it is unnecessary to move your condenser when changing either a stop or a diaphragm. This substage will carry either of Prof. Abbe's condensers, or a cheap condenser made especially for this Microscope. The weight of the Microscope is 7 lbs. complete."

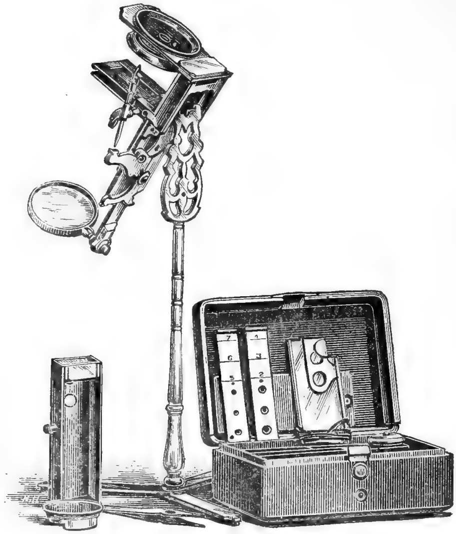
The instrument is made by Mr. C. Baker, of High Holborn, and has been brought out under the personal superintendence of Mr. C. L. Curties. Since the original issue, Mr. Baker has added to the completeness of the design by the application of a rack and centering movements to the substage, and also Mayall's removable mechanical stage.

Lindsay's Simple Microscope.—In the Journal for 1883, p. 708, we reproduced from a German publication two figures of Lindsay's Microscope, which we have since found were probably taken from the specification of the patent granted to George Lindsay in 1742, the first patent known in England relating to a Microscope. As the general design of the instrument is not readily understood by inspection of those figures, we here give a perspective view (fig. 42) of a highly finished model in silver by Lindsay, which we met with in our recent visit to Italy.

The optical arrangement consists (1) of a low-power lens provided with a Lieberkühn (one of the earliest applications of this device after its

introduction by Dr. N. Lieberkühn, in 1738), which slides beneath the cross-arm on the top of the instrument; (2) of two sliding plates each provided with three different powers, numbered from 2 to 7, also sliding beneath the cross-arm; (3) a perforated conical reflector, acting after the manner of a Lieberkühn, which can be applied in conjunction with the low-powers in one of the sliding plates. The mirror is concave, and is hinged on a pivot applied in a socket at the end of the sliding tail-piece. The focusing is by means of a bent lever at the back moving the stage up or down. The limb is hinged at the back to incline on an ornamental support fitted to rotate on the pillar and tripod. A fish-plate, a silver box with perforated sliding lid, articulated stage-forceps, hand-forceps, ivory box for talcs and rings, and six object-slides, together with the whole Microscope, pack neatly in a box about $3\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ in.*

FIG. 42.



GARRISON, F. L.—See *infra*, β (2).

HOWLAND, E. P.—[**Microscopic Projection.**]

["My experience leads me to believe that the direct projection of microscopic objects can only be successfully accomplished in small rooms. For public exhibitions and for projection generally photographs are to be preferred. The use of a projecting Microscope is quite satisfactory with low powers, but it is difficult to concentrate the light sufficiently to admit the use of high powers. These remarks refer to the use of calcium light. With the electric light better results may be obtained."]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 38–9.

PE.—**Ausstellung wissenschaftlicher Apparate, Instrumente, und Präparate.** (Exhibition of Scientific Apparatus, Instruments, and Preparations.) II.

[Exhibition at Berlin. Includes an Electrical Arc Lamp with Microscope—Stricker's Electrical Projection Microscope—Nehmer's Incandescence Lamps—Microscopes by Schieck & Wannbrunn and Quilitz & Co.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 425–31.
Cf. "W.," *ante*, p. 161.

PFEFFER, W.—**Bezugsquelle und Preis einiger Apparate.** (Place to obtain and price of some apparatus.)

[Includes Microscopes.] *Bot. Ztg.*, XLV. (1887) pp. 27–31.

(2) Eye-pieces and Objectives.

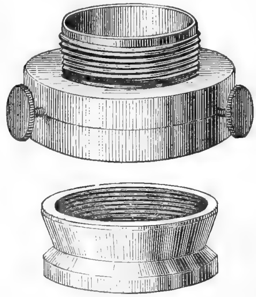
Frazer's Centering Nose-piece for use with Double Nose-pieces.†—"When the nose-piece is moved in the usual way, and one objective put in place of another," writes Mr. A. Frazer, "it seldom happens that an object which was in the focus of one power is also in the focus of the other; and, as a consequence, the operation of focusing must be performed. This

* Cf. Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, p. 43 (1 fig.).

† Trans. Edinburgh Naturalists' Field Club, i. (1885–6) pp. 333–5.

defect may be remedied by making the sides of the nose-piece which hold the objectives of unequal lengths, or by putting an adapter in either side and so correcting for the difference of adjustment for focus. When this correction has been made the convenience of the nose-piece is much increased; but the error of want of concentricity may still remain, i.e. a particular point in the middle part of the field of the lower power may not also be in the centre of the field of the higher. The appliance now described has been designed to remedy the defects both of want of centre and error of focus. It consists of an outer brass collar, which in its upper part is provided with a screw which fits one of the screwed ends of the nose-piece, and in its lower part consists of a brass collar, which is provided with three mill-headed steel screws, placed at regular intervals in its circumference. These screws control an inner ring, into which the objective is screwed, and which may be moved laterally by means of the steel screws. This inner ring, and also the outer ring which supports it, may be made of any suitable length, and by this means the accurate adjustment for focus is effected; while the inner ring being, as already mentioned, capable of a lateral movement, the adjustment for 'centre' may also be accurately made."

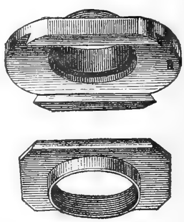
FIG. 43.



Turnbull's Improved Sliding Nose-piece and Adapter.*—The Royal Scottish Society of Arts has awarded a silver medal to Mr. J. M. Turnbull for this apparatus, which he thus describes:—

"It consists essentially of a small face-plate or 'chuck,' which screws into the ordinary 'nose' of the Microscope, fig. 44. On its face this has a slide, which has fitted into it another sliding-piece, and into which the objective is screwed. As many of the other objectives as belong to the instrument are fitted with similar sliding-pieces, which also fit into the first. Once, therefore, an objective is fitted and centered with one of these sliding-pieces, having a sufficient length of tube to bring it very nearly into focus, it can be substituted in a moment for one of lower or higher power, as the case may be; and if an object has been previously centered on the stage with a low power, it will be found accurately centered in the field of that of the higher. I also wish to draw your attention to the fact that all the face parts of this appliance are finished on the lathe, which enables the optical axis of the eye-piece, instrument, and objective to be truly maintained, and does away with the failings of the ordinary double nose-piece in this respect. Another form of this adapter is to have two, three, or more objectives mounted together on one of the sliding-pieces, having on each objective a sufficient length of tube to bring it accurately into focus, and sliding one objective on another, as may be wished, central with the tube of the instrument, a small spring-point retaining it in that position. It is a matter of choice, however, as to which is the better form—whether it will be more convenient to have two or three objectives mounted together, or to have them separate.

FIG. 44.



Having thus described the appliance, I think I may fairly claim for it that it will change the objective of a Microscope with great rapidity, with

* Trans. Edinburgh Naturalists' Field Club, i. (1885-6) pp. 335-6.

very accurate centering, and very close approximate focusing. Having made these claims for it, I commend the apparatus to the attention of all workers with the Microscope, whose time is generally too valuable to waste on matters such as this."

Wales's Cover-carrier for Immersion and Dry Lenses.* — Mr. W. Wales, in exhibiting a non-adjustable 1/5 in. objective with a cover-carrier or cap, said that the idea of affixing a cover-carrier to a lens occurred to him because of the fact that opticians are frequently held responsible for errors of the manipulator in the use of non-adjustable lenses—that a non-adjustable lens corrected for a 10 in. tube would sometimes be used on an 8 in. tube, and this failing to produce good results, the optician would get the credit for making a poor lens. Hence he had fitted a cover-glass to a cap made to screw on to the front cell, or fitting over the objective, and had adjusted and corrected the lens for that particular cover-glass, so that the objective could be plunged down into any fluid without injuring it, and would always be correct for a 10 in. tube without adjustment.

In using an oil-immersion lens with the cover-cap, a drop of oil is placed on the inside of the cover-glass, and the lens can be used in urine, blood, or other liquids. The oil can be allowed to remain there if the lens is perfectly tight, saving time and trouble in repeated examinations of this kind. The cap also serves as a protection to the lens. It can be easily removed and cleansed at any time, and the cover-glass can be replaced if broken.

Paper for Cleaning the Lenses of Objectives and Oculars.†—Prof. S. H. Gage for the last two years has used the so-called Japanese filter paper (the bibulous paper often used by dentists when filling teeth) for cleaning the lenses of oculars and objectives, and especially for removing the fluid used with immersion objectives. Whenever a piece is used once it is thrown away. It has proved more satisfactory than cloth or chamois, because dust and sand are not present, and from its bibulous character it is very efficient in removing liquid or semi-liquid substances. At the author's suggestion it was tried in the Bureau of Animal Industry at Washington, and is now used there almost exclusively.

DALLINGER, W. H.—**The value of the new Apochromatic Lenses.**
[Extract from Presidential Address, *supra*, p. 185.]
Nature, xxxv. (1887) pp. 467–9.

FORGAN, W.—**Notes on Microscope Objectives.**
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 326–9.

LAURENT, L.—**Sur l'exécution des objectifs pour instruments de précision.** (On making objectives for instruments of precision.)
Comptes Rendus, CII. (1886) pp. 545–8 (2 figs.).

NELSON, E. M.—**Object-glasses.**
["For bacteriological work two lenses are absolutely necessary, and a Microscope fitted with a condenser. I consider the condenser so important that I would rather have an indifferent lens with a condenser than a first-rate lens without. A cheap and excellent combination is Seibert Nos. 3 and 7, viz. a 1/2 N.A. 0·32 and water-immersion 1/16 N.A. 1·07. These two glasses cost a little under 5*l.*, and if you know how to test them you can get two first-rate lenses. A third lens is very useful, as the interval between a 1/2 and 1/16 is rather wide. The best lens to put in is a Reichert No. 7*a*; this is a 1/7 of N.A. 0·84. I think its price is about 2*l.* The next series of three, costing about 9*l.*, would be Zeiss A.A., D.D., and G. These are a 2/3 of N.A. 0·31, a 1/6 N.A. 0·82, and a 1/9 N.A. 1·16. These also require selecting."]
Engl. Mech., XLIV. (1887) pp. 562–3.

SCHULZE, A.—**On Abbe's Apochromatic Micro-objectives** and compensating eye-pieces made of the new optical glasses in the works of Dr. Carl Zeiss in Jena, with some general remarks on object-glasses.
Paper read to Glasgow Phil. Soc., 17th Nov., 1886, 13 pp.

* Journ. New York Micr. Soc., ii. (1886) pp. 125–6.
† The Microscope, vi. (1886) p. 267.

(3) Illuminating Apparatus.

Jones's Radial Swinging Tail-piece.*—The principle of causing the illumination to move radially upon the object from the axis to near the horizon and above, as illustrated in Grubb's Sector Microscope,† and subsequently by Nachet (Thury), Zentmayer, Tolles, Bulloch, and others, appears to have been anticipated in the last century in a Lucernal Microscope, designed by "the Rev. John Prince, LL.D., now of Salem, Massachuset's States, North America," and constructed by W. and S. Jones, the application of the lamp being suggested by "Mr. John Hill, Wells, in Norfolk." ‡

Fig. 45.

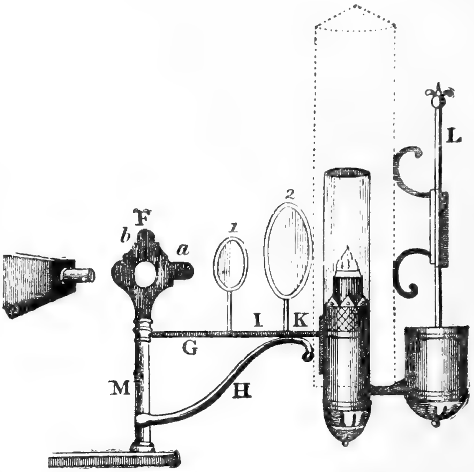


Fig. 45 shows the tail-piece as figured by Adams in plate ix. fig. 5 of the second edition of his 'Essays on the Microscope.' The stage F is supported by a rod passing through a socket M, and attached to a bar, forming a continuation of the limb carrying the projection-box or camera of the Microscope; G I K is the tail-piece connected with the socket M, and strengthened by the bracket H, carrying condensers 1 and 2, and the lamp L. The tail-piece swings laterally round the axis of F, and thus gives radial illumination upon the object on the surface *b a* of the stage.

In what appears to have been an original form of the apparatus which we have seen, a mirror was fitted to slide upon the tail-piece, but no lamp was applied. To the apparatus furnished with a lamp a tablet is attached, notifying that Mr. John Hill had devised the arrangement.

Bausch & Lomb Condenser and Substage. [*Post.*]
The Microscope, VII. (1887) p. 16 (1 fig.).

N., W. J.—**The Two Mirrors. IV.** [*Post.*]
Sci.-Gossip, 1887, pp. 25–7, 52–4 (3 figs.) (*contd.*).

Stricker's Electric Lamp.
["In lecturing before the Society of Natural History at Berlin, Prof. Stricker has employed with much success an electric lamp of 4000 candle power for the projection of microscopic sections upon a screen, employing a magnifying power of 6000 to 8000 diameters. It is stated that the definition obtained is very satisfactory." Cf. Journal, 1886, p. 502.]
Science, IX. (1887) p. 55, and see Pe, *supra* (1).

(4) Other Accessories.

Haswell's Rotating Stage and Circular Slides for large Series of Sections.—This apparatus was more especially designed by Mr. W. A. Haswell for the purpose of enabling students conveniently to examine series of sections of objects which they have not the opportunity of sectioning for themselves. It is thus more particularly intended for special

* Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, p. 58 (1 fig.).
† See this Journal, 1880, p. 1056.
‡ See Adams's 'Essays on the Microscope,' 2nd ed., 1798, p. 84.

type-series of sections of such objects as, when cut into thin sections, would occupy a very large number of slides of the ordinary form,—such as the earthworm, leech, fluke, *Amphioxus*, chick, mammalian embryos, and the like: but besides its use for demonstration purposes it is also claimed to be of the greatest service in investigation.

The sections are mounted on circular discs of glass *a*, figs. 46 and 47, 9 in. to 11 in. in diameter, with a circular aperture of 3 or 4 inches in the centre. The method of procedure is as follows:—The glass disc after being carefully cleaned is smeared over thinly with a very thick solution of shellac in creosote. It is then laid on a sheet of white paper on which concentric circles a quarter of an inch or thereabouts apart, from the size of the disc downwards, have been ruled. The sections, cut by an automatic microtome, are laid round the outer edge of the disc in concentric circles, their position being regulated by the concentric lines on the paper. To facilitate the arrangement of the section it is advisable in paring down the block of paraffin to leave the sides not quite parallel, but inclined to one another at

Fig. 46.

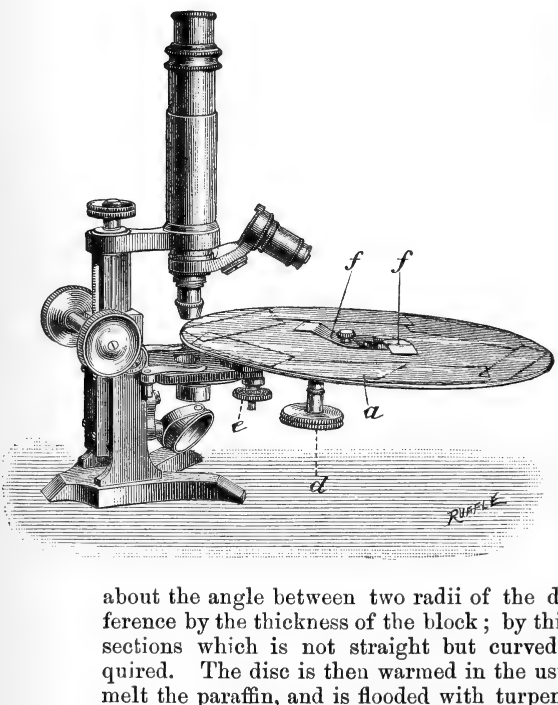
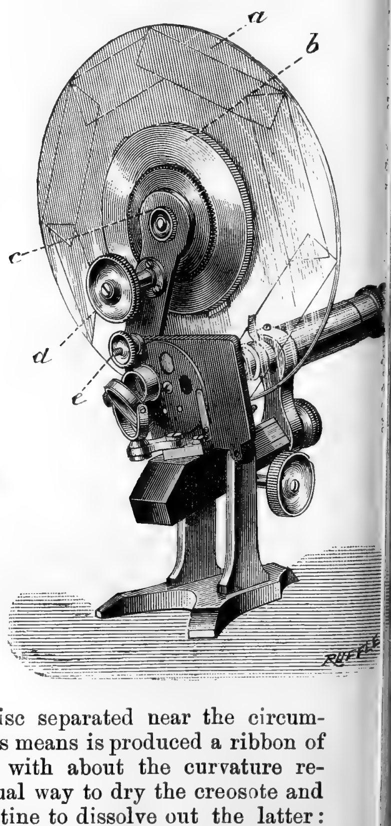


Fig. 47.



about the angle between two radii of the disc separated near the circumference by the thickness of the block; by this means is produced a ribbon of sections which is not straight but curved, with about the curvature required. The disc is then warmed in the usual way to dry the creosote and melt the paraffin, and is flooded with turpentine to dissolve out the latter: balsam is poured on and the sections are covered with oblong strips of thin cover-glass. In this way may be regularly arranged on the disc a series containing thousands of sections.

The apparatus for enabling the series to be examined is a brass revolving

table *b* carried on a horizontal arm *c*, which is fastened to the right-hand corner of the stage of the Microscope by a screw passing through a hole in the stage and provided with a nut *e*. The glass disc is centered on the circular table and fastened with a pair of spring clips *f f* placed near the centre. The table, carrying with it the disc, is rotated by a rack and pinion or rather cog-wheel movement, worked with the right hand by means of a milled head *d* placed underneath. The concentric circles of sections are brought under the tube by the movement of the horizontal arm, by means of which the centre of the revolving table is brought nearer to or carried further away from the centre of the stage.

Warm and Cold "Stages."—In studying the anatomical elements of a warm-blooded animal, and other phenomena which naturally occur under the influence of a temperature considerably above that of the surrounding air, it is necessary to have some means of maintaining a condition as to temperature resembling that of the living organisms, or even, as in the experiments of Dr. Dallinger, described *supra*, p. 185, of raising the temperature to an abnormal point. We summarize here some of the principal suggestions that have been made for this purpose (as well as for producing cold), excluding such as have previously been recorded in this Journal.

A very crude process described by Raspail * was to put the object in water in a watch-glass on the stage, a spirit-lamp being placed beneath it, which served both for heating the water and giving light to the object. The objective was covered by the globular end of a thin glass tube, which dipping into the water, prevented the obscuration of the object by vapour and protected the objective. Harting,† following, but not quoting, Goring and Pritchard ‡ proposed to substitute for the glass tube a brass one, closed by a plane plate of glass. Schacht § also heated the slide direct by a minute wax taper placed (for short periods) below the opening in the stage.

Apart from these methods, four different principles have been adopted for heating microscopic objects: (1) by hot air; (2) by electricity; (3) by conduction through metal plates; and (4) by water.

1. *Air*.—This is perhaps the least convenient medium of all for heating microscopic objects.

Prof. G. Fritsch commends *Dr. Senarmont's* ‖ apparatus as a very simple and handy stage, which "in its arrangement is to be preferred to those of Max Schultze and Stricker." It consists (figs. 48 and 49) of a hollow

FIG. 48.

box of tin K, open at one end, and having at the other an aperture in the lower surface, to which is attached a cylindrical tube of mica. The box is

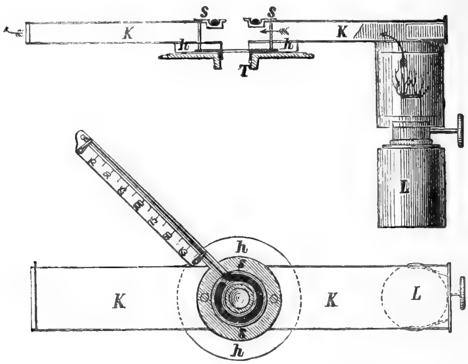
* Raspail, L. V., 'Nouveau Système du Chimie Organique,' 2nd ed., i., 1838, pp. 222–3 (1 fig.). † Harting, P., 'Das Mikroskop,' 2nd ed., ii., 1866, pp. 146–7 (1 fig.).

‡ Goring, C. R., and Pritchard, A., 'Microscopic Illustrations,' 1830, pp. 55–6 (2 figs.). § Schacht, H., 'Das Mikroskop,' 3rd ed., 1862, p. 79.

‖ Bericht u. d. Wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Löwenherz), pp. 305–6 (1 fig.), and pp. 355–6 (1 fig.).

pierced with a circular aperture in the centre, that in the upper surface being open, and that in the lower closed by a plate of glass. On the top is screwed a plate *s*, with a deep annular groove to hold the thermometer-bulb, the tube of which lies in a groove along the upper surface of the box to the left. A lamp L is placed under the mica cylinder, and thereby warm

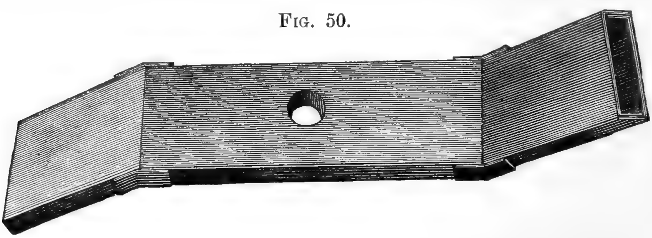
FIG. 49.



air is made to pass through the box, the heat being transmitted from the centre plate into the object laid upon it. It is isolated from the stage T by means of an ebonite ring *h*.

Dr. Beale also in 1865 * described and figured a simple plan (fig. 50) of heating objects by hot air. It consists of a long copper box, open at both ends, the middle part of which lies flat on the stage. One end is bent down obliquely so as to project over the side of the stage, while the other is similarly bent up. A spirit-lamp being placed at the lower end a current

FIG. 50.



of hot air passes through the box and escapes at the upper end. The centre of the box has its lower wall composed of glass, while at the upper part is an opening to allow of the hot air reaching the slide.

Valentin's stage described under (4) Water *infra*, can also be used as a hot air stage.

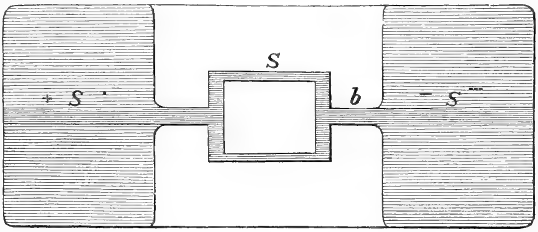
2. *Electricity.—Prof. S. Stricker* recommends † the use of electricity as a means of heating a stage, thus describing it:—A better method than any consists in the conversion of a constant current of electricity into heat. In microscopical investigation only a very small absolute quantity of heat is required, and indeed it is not necessary to warm the stage in its whole extent, but only its centre, or what is still better, the cover-glass placed on

* 'How to work with the Microscope,' 3rd ed., 1865, p. 129 (1 fig.). See also 5th ed., 1880, p. 189 (1 fig.).

† Stricker, S., 'Manual of Human and Comparative Histology.' Transl. by H. Power, 1870, pp. xii.-xvii. (3 figs.)

a slip of caoutchouc. An amount of heat so small as this we may reasonably expect to obtain from the interruption of even feeble currents of electricity. It is well known that the heating of a wire introduced into the arc of a constant current increases with the diminution in diameter of the wire. For this purpose, therefore, we employ a proportionately thin wire attached to the centre of a glass plate, the ends being in connection with the electrodes of a constant battery. When the current is closed the temperature of the centre of the glass plate is raised. The attachment of the wire presents, however, certain inconveniences, and we possess in tin-foil a more appropriate means at our disposal. The tin-foil should be cut into the form represented by S in fig. 51, and then glued to a glass slide; the

FIG. 51.

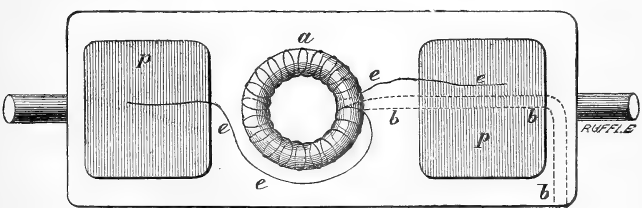


extremities of the tin-foil being introduced into the arc of a constant current. A second strip of tin-foil of the same breadth as that attached to the slide *b*, is wound round the bulb of a thermometer and introduced into the circuit at any convenient point. This furnishes the means of correctly estimating the temperature attained by the centre of the slide when all the secondary conditions are uniform. These latter can, however, be estimated by comparison and the due employment of a thermometer—a proceeding that is always requisite whatever may be the mode of heating employed. In order to accomplish this, a fatty substance, the melting point of which is known, should be placed at the point where the object is situate, and the reading of the mercury should be taken at the moment that the fat begins to melt.

As the temperature diminishes as the square of the strength of the current, this decrease can to a certain extent be covered by diminishing the transverse section of the tin-foil, so that if a weak current be in use the strip of tin-foil must be made proportionately narrow.

In order to exercise a direct control over the temperature of the cover-glass, a thermometer should be attached to the slide itself. In fig. 52, *a* is

FIG. 52.

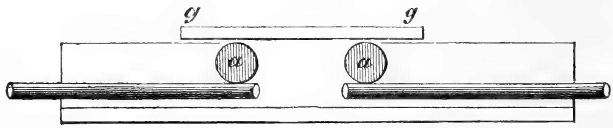


the bulb of the thermometer, the dotted line *b* indicating the direction of the tube. Both the tubes and the bulb lie in a groove made in a hard caoutchouc slide. A coil of very fine copper or platinum wire *e* is wound

round the bulb and the ends lie on the metal plates *p p*, which are also connected with the electrodes.

Fig. 53 also gives a longitudinal section of the stage; *g g* is the cover-glass upon or to the under surface of which the object to be examined is fixed. The cover-glass is in contact not only with the surface of the

Fig. 53.



slide, but also with the coil of wire surrounding the bulb of the thermometer the transverse section of which is seen at *a a*. When the circuit is closed the wire becomes heated and acts on the one hand upon the mercury, and on the other upon the cover. The hard caoutchouc is a bad conductor of heat, and hence the cover-glass receives the greater part of the heat.

Fig. 54.

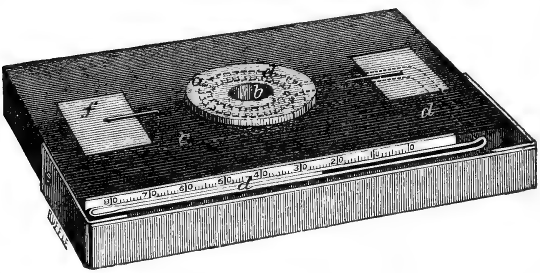


Fig. 54 shows the Stricker stage as figured in the 'Handbook for the Physiological Laboratory,'* *b* being the central chamber (surrounded by a copper disc *a*) warmed by the current, *f* a copper plate with a corresponding one on the other side to which the electrodes are applied, *c* a platinum wire by which the two plates are in communication and which is coiled round the bulb of the thermometer *d*.

Dr. S. T. Stein † also uses a platinum spiral (fig. 55) inserted between

Fig. 55.

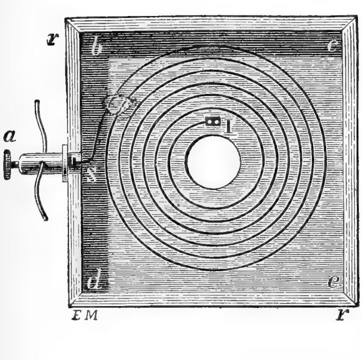
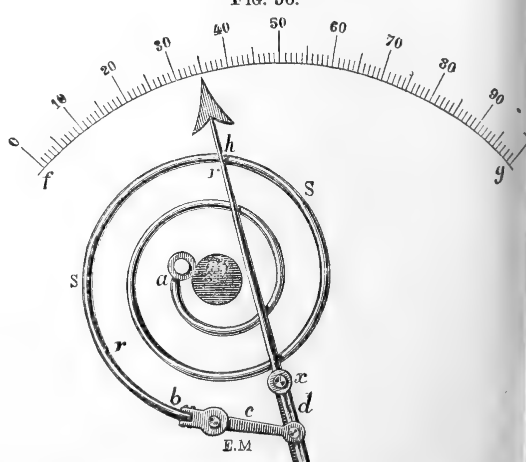


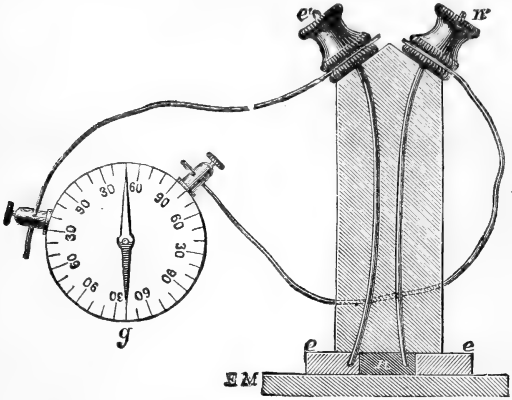
Fig. 56.



* Burdon-Sanderson, J., E. Klein, M. Foster, and T. L. Brunton, 'Handbook for the Physiological Laboratory,' 1873, fig. 14.
† Zeitschr. f. Wiss. Mikr., i. (1884) p. 161.

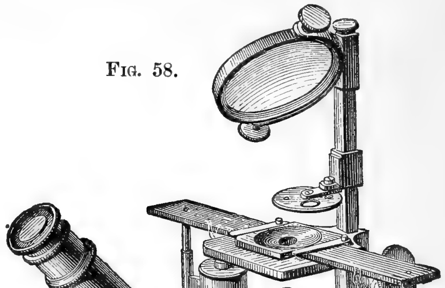
the upper and lower plates of the stage of a Microscope, and heats it by the electric current. To measure the degree of heat, he employs the bi-metallic thermometer (fig. 56). The spiral is made of brass S and iron *r*

Fig. 57.



soldered together, and by the difference of expansion in the two metals the spiral contracts or opens. The inner end *a* is attached to the stage close to its opening, while the free end *b* acts, through an arm *c*, on an index *d* which is pivoted at *x*, and whose point *h* moves along the scale *f g*. Or the thermo-electric apparatus (fig. 57) may be used, where *e e* is iron and *n* German silver, two wires *e′* and *n′* leading to the galvanometer *g*, the needle of which is deflected more or less, according to the temperature of the stage.

Fig. 58.



3. *Hot Plates.—M. C. Chevalier's* * is shown in fig. 58. It consists of a metal plate with a central aperture, beneath the two ends of which are placed spirit-lamps which slide up and down on the projecting stems. This apparatus was intended for use with Chevalier's Universal or Chemical Microscope (a modified form of the latter shown in fig. 58), in which the objective is beneath the object. One or

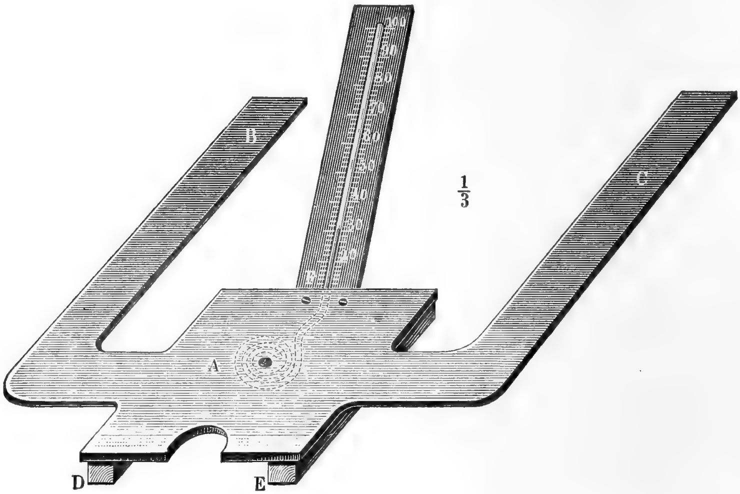
* Chevalier, C., 'Des Microscopes et de leur usage,' 1839, p. 97 (1 pl.).

both of the lamps can be used according to the degree of heat required, and a thermometer can be applied if desired.

Prof. Max Schultze's * (fig. 59) is figured in most foreign treatises, and was the first fairly successful hot stage.

It consists of a brass plate A, 1–2 mm. thick, notched behind so as to fit to the pillar of the Microscope, and attached to the stage by clamps. It has two arms B C, 170–200 mm. long and 30 mm. broad, bent forwards at

FIG. 59.



right angles. Spirit-lamps are placed under the ends of these arms and an object on the plate (then elevated 10 mm. above the stage) can be readily raised to a temperature of 35°–45° C. A small hole at A allows light from the mirror to pass to the object, the temperature of which is recorded † by a thermometer F, rising obliquely above the stage, the bulb being wound twice round the aperture at A. The upper part of this bulb is flat, so as to lie close to the central plate, and the bulb is inclosed in a box or cover to protect it from changes in the external temperature. Two wooden ledges D E at each side of the box, support the apparatus on the stage and retard the abstraction of heat through the stage. This apparatus has a special defect according to Engelmann. The temperature of the object is occasionally reduced very considerably by the metallic setting of the lens and the body-tube, so that the focal distance of the objective exerts a marked influence on the observations. The insertion of a bad conductor of heat between the lens and the body-tube has been proposed. An ivory tube 30 mm. in height applied in this manner lessens the defect very materially.‡

Dr. Ransom in order to employ the stage for cold also, suggests making it of copper instead of brass, the former metal being so much better a

* Arch. f. Mikr. Anat., i., 1865, p. 1; Frey, H., 'Das Mikroskop,' &c. Transl. by Cutter, 1880, pp. 101–2 (1 fig.); Harting, op. cit. pp. 147–8 (1 fig.); Dippel, L., 'Das Mikroskop,' 2nd ed., 1882, pp. 653–5 (1 fig.); Robin, C., 'Traité du Microscope,' 1877, pp. 161–2 (1 fig.).

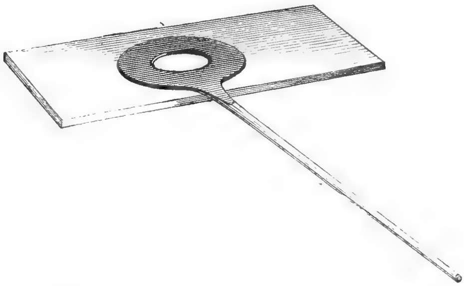
† Frey says "wirklich" and Ranvier "approximativement."

‡ See Frey, op. cit., pp. 101–2.

conductor,* while *Sig. Koritska* of Milan makes the ends of the arms B C terminate in discs, to give an extended heating surface.

Prof. Stricker's first form † consisted of a copper ring or rod inserted into a glass slide so as not to project beyond the surface. A second rod with a spiral coil is slipped over the free end of the first rod, and its extremity heated by a spirit-lamp. This has been further simplified ‡ by making the ring and rod in one piece, as shown in fig. 60.

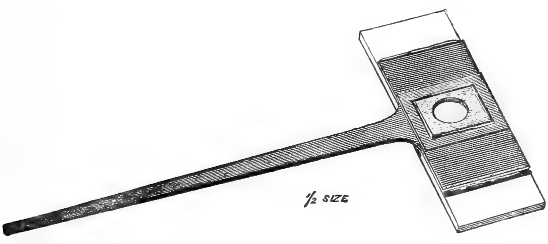
Fig. 60.



Two simple modifications of this form are also shown in figs. 61, 62, and 63.

The first § (figs. 61 and 62) has an oblong copper plate 2×1 in., from one side of which projects an arm of the same metal 4 or 5 in. long. The plate has a round aperture in the centre 1/2 in. in diameter, and is fastened to an ordinary slide by sealing-wax. The rod is heated near

Fig. 61.



its end by a small spirit-lamp as shown in fig. 62, and the heat is conducted by the rod to the copper plate, and from this to the preparation. If an object is under examination, such as white blood-corpuscles, which it is desired to warm to about the temperature of the body, a small fragment of a mixture of white wax and cacao butter melted at about 30° C., should be placed upon the copper (fig. 62). The lamp is now gradually approached along the rod until it arrives at a point, the heat transmitted from which is just sufficient to partially melt the fragment, and it is then left burning at that spot.

The other form (fig. 63) consists of a square copper plate *b* with a central opening *c*. A rod *e* projects from its under surface (upper as

* Beale's 'How to work with the Microscope,' 5th ed., 1880, p. 189.

† Op. cit., pp. xvii.–xviii. (1 fig.). ‡ Burdon-Sanderson, op. cit., pp. 6–7 (1 fig.).

§ Schäfer, E. A., 'A Course of Practical Histology,' 1877, pp. 18–20 (2 figs.).

seen in the drawing), and fits into a groove in the glass slide *a*. A pin *d* also fits into a hole at the end of the groove. The rod is heated by a spirit-lamp.*

FIG. 62.

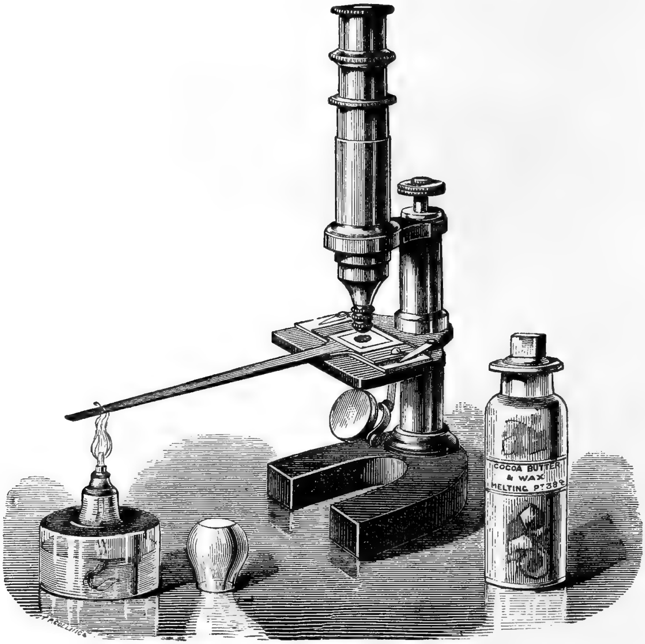
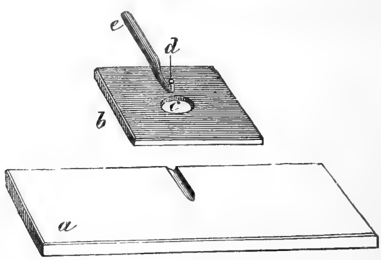


FIG. 63.



Prof. Stricker's more complete form † is shown in fig. 64. It consists of a block of black vulcanite $3 \times 1\frac{1}{2} \times 1/4$ in. The central cylindrical chamber *b* is closed below by a glass plate and surrounded at the top by a copper disc *a*. The bulb of the thermometer passes round the chamber, as shown by the dotted line *d*. Its capillary tube lies in a trough, one side of which is formed by the back of the block and the other by a metal plate screwed to it, the form of which is shown in the fig. The tube *c* (for gases) leads into the chamber, and a second tube leads from it through the projecting metallic arm shown at the top. This arm, which is

* Burdon-Sanderson, op. cit., fig. 12.

† Stricker, op. cit., pp. xvii.–xviii. (1 fig.). Burdon-Sanderson, op. cit., p. 7 (fig. 2).

in one piece with the disc *a* is of such a size that the rod *g*, fig. 65, fits in it by means of the spiral *f*, and by this rod the chamber is heated.*

FIG. 64.

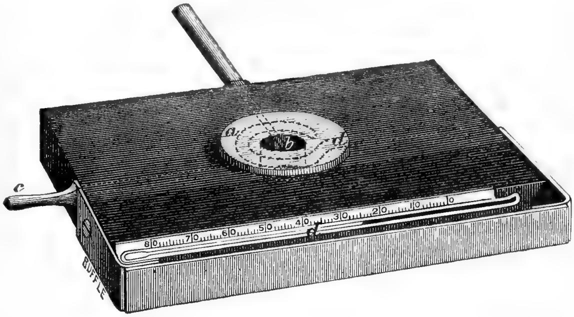
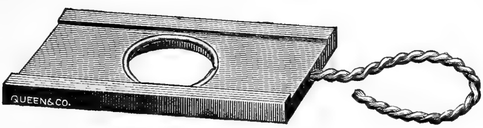


FIG. 65.

Mr. J. S. B. Bell also recently suggested † a modified arrangement for maintaining the preparation at any temperature from that of the room up to 100°. It consists (fig. 66) of a mahogany slide 3 × 1½ × 1/4 in., with a flat groove 1/16 in. deep for the ordinary glass slide to lie in. In the

FIG. 66.



centre is a round hole 1 in. in diameter, which incloses a copper ring, made by bending No. 16 wire into a ring slightly less than the hole. The two ends pass longitudinally through the stage and are twisted together and curled round. The stage is heated by a spirit-lamp held to the twisted wire, and when the required temperature is reached the lamp is moved back along the wire to a point that will just maintain the temperature. At the time the stage was exhibited, the room was 62° F.; the slide was heated to 82°, and the temperature kept stationary. It was then heated to 100°, and kept stationary for half an hour. In this arrangement the heated wire is isolated from the stage and from the glass slide by means of the wood in which it is placed.

Mr. W. H. Symons' first form of stage ‡ for steam, water, a saturated

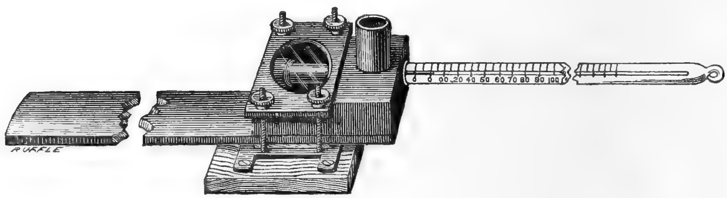
* Dr. C. H. Golding-Bird in 1875 suggested (Quart. Journ. Micr. Sci., xv., 1875, pp. 373–4) a "differential" warm stage made with copper and iron wire, and intended to correct the error which he considered the preceding forms of stage to give rise to, by reason of the difference of temperature between the copper and the centre of the glass slide.

† Micr. News, iv. (1884) pp. 19–20; and cf. Queen's Micr. Bulletin, ii. (1885) p. 4, and iii. (1886) p. 13 (1 fig.).

‡ See this Journal, 1882 p. 21.

solution of chloride of calcium, or glycerin, was intended for comparatively low temperatures, being furnished with a special form of thermometer graduated to 150° C., and as it was somewhat expensive and liable to get out of order, he devised a second form * (fig. 67) which "can be obtained

Fig. 67.



for a nominal sum, is capable of being used with an ordinary thermometer, and is available for all temperatures within the range of that instrument."

A block of copper 6 cm. by 4 cm. by 2 cm., has an aperture 2·5 cm. in diameter passing quite through it, but closed on both sides by thin glass or mica held between thin pieces of cork by means of plates screwed down, as shown in the fig., sufficiently tightly to prevent leakage. A slightly tapering canal is drilled through the block lengthways from one end, meeting and extending a little beyond the aperture. This is for a thermometer 33 cm. long, the bulb of which passes across the aperture. The tube is graduated to 600° F.† An open tube of one piece with the rest communicates with the canal. A piece of copper 3 mm. thick brazed on the block before the aperture is drilled, extends about 15 cm. beyond the end opposite to the thermometer. The part placed on the stage is mounted on some nonconducting substance, such as a piece of well-seasoned mahogany.

The thin glasses or mica having been firmly packed in their places, and the thermometer put in position, taking care that it does not come into contact with any portion of the metal, perfumed oil is carefully poured into the open tube, until when in a horizontal position it completely fills the aperture in the block; the whole arrangement is then placed on the stage so that the aperture shall correspond with the optic axis. The object to be examined is placed on the upper thin glass.

4. *Water.*—This furnishes by far the best means of heating objects, a constant temperature being more readily maintained than with any other method. Changes of temperature can also be rapidly effected.

Dr. Polaillon ‡ suggested a flat box 1·0–1·5 cm. deep and of the same form as the stage. The upper and lower faces were of glass. There were two indiarubber tubes, one leading from a vessel of hot or cold water placed on a higher level, and the other leading into a lower vessel to catch the waste water.

Prof. Stricker's § original idea is shown in fig. 68, when the two tubes and rod at the upper side are removed. It consists of a metal box with a central perforation for light, the preparation being either placed upon a cover-glass cemented down, or so arranged that the central aperture serves as a cell. At opposite points of the box two tubes are inserted for the passage of water.

* Pharmaceutical Journal, xiii. (1882) pp. 1–4 (3 figs.), 21–2.

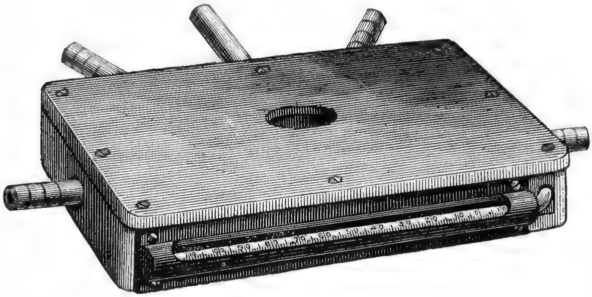
† The thermometer was described as fitted by means of a cork, but Mr. Symons found this got dry and leaked, and subsequently tried cement (sulphur and iron).

‡ Journ. de l'Anat. et Physiol., 1866, p. 133.

§ Op. cit., p. xix.

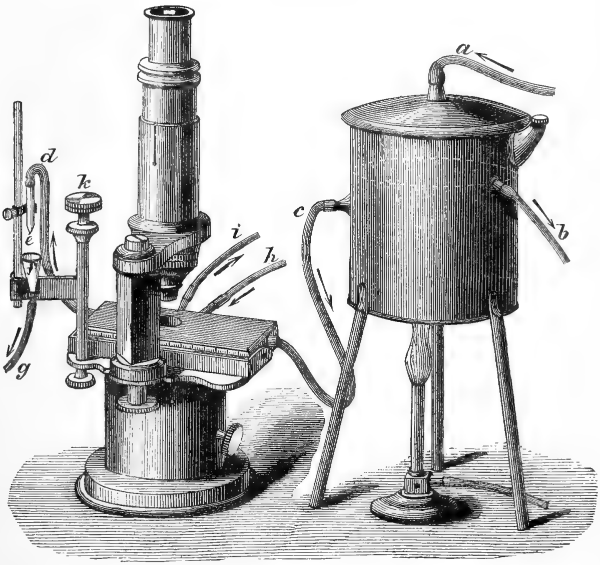
Dr. Burdon-Sanderson * modified Stricker's stage by the addition of two pipes for passing gas into the central chamber, and a rod for heating the stage by that method if desired. As modified it is shown in fig. 68, and

FIG. 68.



in use in fig. 69. In the vessel the water is maintained at a constant level, indicated by the dotted line, and at boiling temperature. *a* is the supply tube, *b* the waste tube, *c* the tube leading to the stage, and *d* a tube by which the hot water leaves the stage, terminating in a conical

FIG. 69.



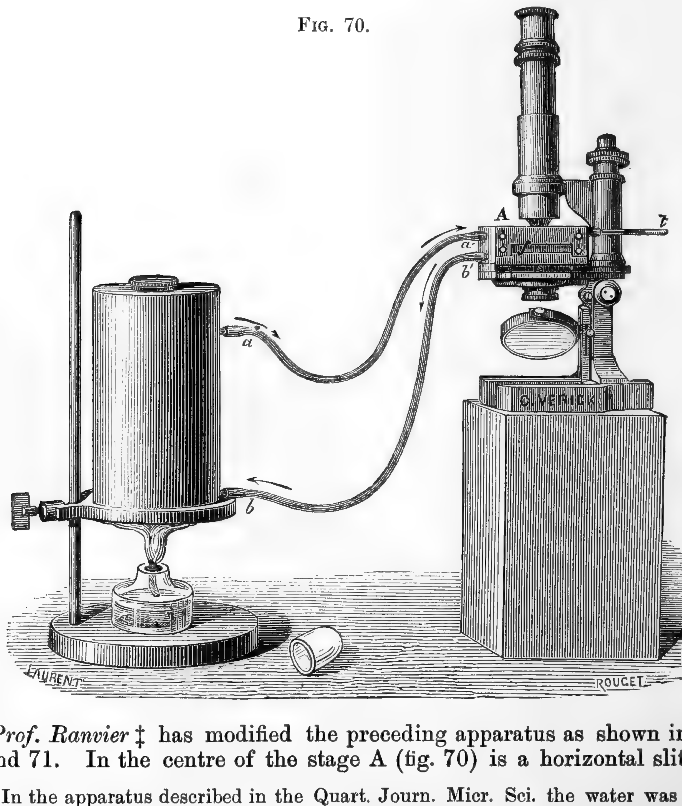
dropper *e*. A funnel *f* collects the drops which fall from *e*, and *g* is the waste. The rate of flow is determined by varying the height of *e* by means of the sliding screw on which it is supported. It admits of more exact adjustment by means of a fine screw which works in the axis of the

* Burdon-Sanderson, op. cit., pp. 15–6, fig. 3; Quart. Journ. Micr. Sci., x. (1870) pp. 366–7 (2 figs.).

vertical column on which the escape tube is supported. This column is firmly fixed in the stage of the Microscope, its axial screw terminating above in a milled head *k*. *h* and *i* are tubes for gas.*

Dr. Klein says † that in the employment of this apparatus several difficulties are encountered. For instance, the temperature of the water receptacle is only in part controlled by the regulator, and the temperature of the stage is subject to variation according to the rate at which the water flows into and escapes from it, so that unless great care is taken in the adjustment constancy cannot be relied on. Another practical difficulty lies in the fact that the temperature of the water in the receptacle is different from that in the stage, the rate of flow being so inconsiderable that there is necessarily a great loss of heat by radiation from the metal surface. If the stage is not fitted with a thermometer this difference of temperature may be determined once for all by comparative measurements, so that the true temperature of the stage can then be known at any time by deducting the ascertained loss of heat, i. e. the ascertained difference above referred to, from the temperature to which the regulator is adjusted.

Fig. 70.



Prof. Ranvier ‡ has modified the preceding apparatus as shown in figs. 70 and 71. In the centre of the stage A (fig. 70) is a horizontal slit *f*, in

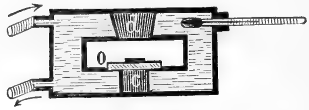
* In the apparatus described in the Quart. Journ. Micr. Sci. the water was in the first instance conveyed to a loop-shaped metal tube surrounding the upper part of the objective for the purpose of keeping it warm, a vulcanite ring preventing the heating of the Microscope-tube. From the loop the water passed to the stage.

† Burdon-Sanderson, op. cit., p. 7.

‡ Ranvier, L., 'Traité technique d'Histologie,' 1875, pp. 41–2 (1 fig.)

which the slide O (fig. 71) with the object can be placed. Above and below this are other vertical openings c and d, communicating with it, the upper one d receiving the objective, and the lower one c a diaphragm of glass. To prevent cooling, the space between the objective and the sides of the upper opening can be stopped with cotton wool. A thermometer t is inserted in a tube at one side of the apparatus, as shown in both figures.

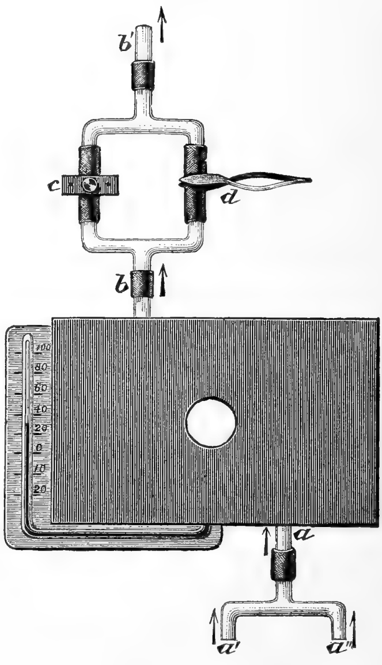
FIG. 71.



It is essential, in order to insure the same temperature of the water in the reservoir and stage, which communicate by the circulating tubes $a\,a'$ and $b\,b'$, that the stage should be above the level of the water in the vessel, and therefore that the Microscope itself should be elevated as shown in fig. 52.

Professor Ranvier describes the great advantage of the apparatus to consist in the fact that a constant temperature can be readily maintained for several hours. When the temperature of the water has been raised to 40° C., an observation can be continued for a quarter of an hour without any reheating, as the cooling proceeds so very slowly. The preparation is at the very centre of the stage, and the aperture below being closed by a glass diaphragm and that above by cotton-wool, the object is protected against all the usual causes of cooling, and its temperature is very nearly that indicated by the thermometer.*

FIG. 72.



Dr. M. Flesch † suggests a form of stage available for both high and low temperatures, and especially for rapid changes of temperature, also allowing the Abbe condenser to be used for illumination as well as the ordinary polarizing apparatus.

The author discusses some of the preceding stages, condemning Max Schultze's. He considers Ranvier's to come the nearest to fulfilling the conditions which he laid down for himself. Bartley's ‡ and Symons' § he considers to each present important advantages; the former does not, however, allow the temperature to be determined with exactness; the latter he fears would not admit of very rapid changes, and the cover-glass on which the object is placed would be liable to be broken or displaced by quick cooling.

The stage (fig. 72) is a shallow box, into which pass the tube a for

* To prevent the cooling of the object by the objective, especially when the focus is short, it has been suggested to place an ivory tube 30 mm. long over the objective. Dippel, tom. cit., 1882, p. 655.

† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 33–8 (1 fig.).

‡ See this Journal, 1881, p. 672.

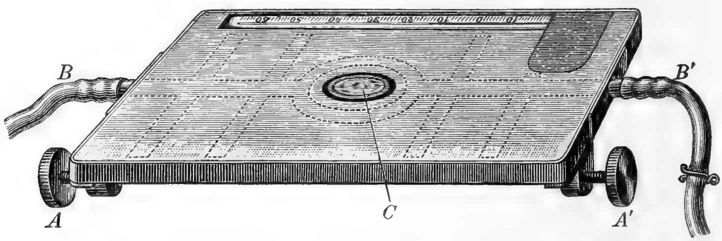
§ See this Journal, 1882, p. 21.

introducing hot or cold water and the tube *b* for carrying it away. The former is attached to a T tube—one branch *a'* being connected with a vessel of hot water, and the other *a''* with cold water, a pinchcock closing the one not in use. A double T tube is in connection with *b*, through one branch of which the water ordinarily flows in drops controlled by the screw *c*. The object of the double tube is to facilitate an almost instantaneous change of temperature. If the pinchcock *d* on the second branch is opened at the same time as the cold-water vessel is placed in connection with the stage the water will rapidly circulate, and the stage will be filled with cold water only, so that in a few seconds the temperature may be lowered 30°.

Dr. Flesch at the time his paper was written was not wholly satisfied with his apparatus, and expected to improve it.

*Löwit's Hot Stage for High Powers.**—The thickness of the ordinary hot stage does not allow the condenser to be brought close to the under side of the slide, so that the object is not in the focus of the illuminating beam, and the use of high powers is obstructed. Dr. Löwit's hot stage (fig. 73) is intended to remedy this difficulty.

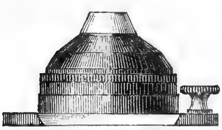
FIG. 73.



In general form the stage is like that of Stricker but thinner; the water circulates by means of the two tubes B B' and the internal tubing shown by dotted lines. The screws A A' are for centering.

Into the central opening C can be introduced the upper of the two lenses of a condenser, the upper lens, as shown in fig. 74, being much coned away, so that the top surface lies flush with the stage. The object can thus be placed in the focus of illumination, and the full effect obtained even with homogeneous-immersion lenses.

FIG. 74.



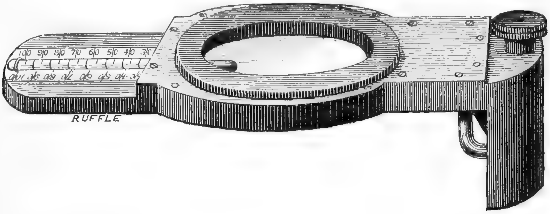
To maintain a constant temperature the author finds it better to admit the water from a vessel in which it is kept at boiling-point, and as soon as the temperature in the stage has risen to 30°–40° C. to check the flow by closing the outflow tube until the water can only issue in drops; by regulating the outflow the chamber can be maintained at any desired temperature. With a slow circulation, however, the thermometer will not indicate the temperature of the object, but only that of the water in the neighbourhood of the bulb, which will differ according to the side at which the water enters, the water of course being colder towards the exit side. Thus the thermometer might register 50° C. when the hot water enters at B' and 40° C. when it is admitted at B, so that in the

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 43–6 (1 fig.).

former case the object will be at a lower and in the latter at a higher temperature than the thermometer. If it is desired to know exactly the temperature of the object a rapid circulation must be maintained, and a thermo-regulator used.

Dr. G. Valentin's * (fig. 75) is intended not only for heating and

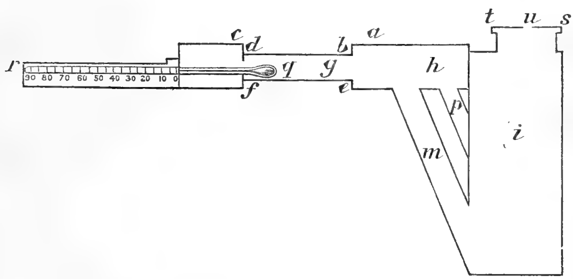
FIG. 75.



cooling by water, but also by air, and for a great variety of microscopica observations which require a closed chamber.

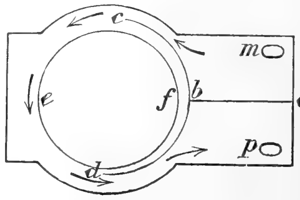
It consists of a vessel *i* (fig. 76), projecting over the side of the stage, and communicating with the chamber *h g* by the two pipes *p* and *m*. The

FIG. 76.



centre is formed of two glass discs *b d* and *e f*, *b d* being sunk below the level of *a c* to form an outer chamber, which can be closed with cover-glass when required. It is removable, so as to give access to the interior. (A section of the interior of *h g* is shown in fig. 77, where *e f* is the bottom plate of fig. 76 and *m p* the openings of the two pipes; *a b* and *c d* are two metal partitions which serve to regulate the flow of the fluid, as shown by the arrows.) A thermometer *q r* also passes into the chamber, which terminates at this end at *d f*.

FIG. 77.



To use it for heating with water the top *s t* is removed and water poured into *i* until full, and a spirit-lamp placed beneath it. The steam escapes at the small hole at *u*, or, if the water is required to boil, the top is removed and a pipe of larger opening put on. For heating with air the spirit-lamp is placed as before, or the vessel *i* is plunged in hot water.

* Valentin, G., 'Die physikalische Untersuchung der Gewebe,' 1867, pp. 421-8 (4 figs.).

If it is desired to cool the object the end of the vessel *i* can be placed in cold water, or for low temperatures in ice and salt, the chamber being then filled with pure alcohol instead of water.

The apparatus can also be used as a moist chamber or for steaming objects. In this case only a little water is placed in *i*, *u* being closed with wax and the object placed at *g*. If the glass *b d* is too thick one or other of the following plans may be adopted. The object may be placed on *b d* and covered, and a communication made between the interior (filled with water) by a piece of cotton. Or *b d* may be removed and a brass plate substituted with a square aperture, over which the object is suspended on a cover-glass.

For a dry chamber it is only necessary to introduce sulphuric acid or potash sticks into the vessel *i*.

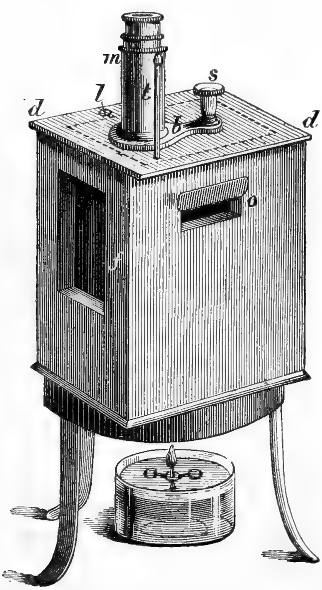
Gases can be introduced through *s t*, the object being suspended over the aperture in the brass plate as before, or the action of the vapour of ether, chloroform, &c., upon different objects may be investigated.

It is also adapted for all kinds of observations (spectroscopic, fluorescent, or otherwise) on fluids, especially where a constant thickness is required.

Prof. J. Sachs encloses the Microscope itself in a special chamber which he describes as follows:*—

"Convenient contrivances for observing the action of particular higher or lower temperatures on plants or parts of plants of considerable size are easily arranged. It is more difficult to expose microscopic objects to a particular higher or lower temperature in such a manner that it can easily and certainly be observed, and that the temperature of the object is also that indicated by the thermometer, or nearly so. All these requirements are fulfilled by the very cheap heating apparatus for the Microscope represented in fig. 78.

Fig. 78.



The size of the heating apparatus must vary with that of the Microscope; mine is constructed for one of Hartnack's ordinary instruments. The box is nearly cubical, and has double walls of sheet zinc at the bottom and sides, inclosing a space 25 mm. thick, which is filled with water through the hole *l* (fig. 78). It is quite open above, but in the front side-wall is an opening *f*, which is closed by a glass plate well fitted but not otherwise fixed. This window is sufficiently large, and is so placed that it allows enough light to fall on the mirror of the Microscope which stands in the box. The height of the box is so arranged that the upper rim of the double wall is on a level with the arm *b* of the Microscope. The opening of the box is closed by a thick cardboard cover *d d*, in which an opening is cut exactly to fit the arm *b*. By the side of the tube of the Microscope a round hole is cut in the cover through which a closely fitted small thermometer *t* passes, so that its bulb hangs

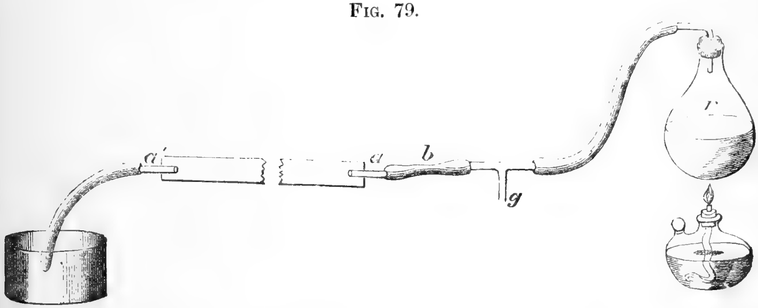
* Sachs, J., 'Text-book of Botany,' 2nd ed., 1882, pp. 735–7 (1 fig.).

near the object. The box is painted on the inside with black varnish, and a piece of cardboard moistened with water lies beneath the foot of the Microscope in order to prevent its moving and to keep the air within moist. The focus is easily adjusted to the object by means of the fine-adjustment *s* which projects above the cover; two openings in the side, one of which is shown at *o*, enable the slide bearing the object to be moved, when necessary, by a pair of forceps. It is still more convenient to fix the slide on a wire which goes through a cork fitted to the opening *o*.

It is easy by means of this heating apparatus to observe and demonstrate the influence of temperature on protoplasm-currents. To take observations at low temperatures it is sufficient to enlarge the hole *l*, in order from time to time to place pieces of ice in the cold water.*

Maintaining a constant temperature and varying the temperature.—For varying the temperature with rapidity, *Prof. Stricker* suggested† the arrangement shown in fig. 79 (centre of stage omitted). To the tube *a*, com-

FIG. 79.



municating with the stage, is attached an indiarubber tube *b*, which leads to a flask *r* for generating steam. The steam escapes through the perpendicular limb *g* of the T-shaped tube which is interposed between the flask and *b*, because it here meets with the least resistance. When this is prevented by means of a caoutchouc tube and a clip, the steam will pass through the slide and heat it. If the lamp is removed, the flask in cooling will act by way of suction on the vapour in the slide and air will enter, or iced water may sucked up through the tube *a'* and rapid cooling effected.

A preparation may also be subjected to sudden alterations of temperature by the apparatus shown in fig. 69.‡ A clip is placed on the tube *c*, leading from the water receptacle by means of which the access of the warm water to the stage may be interrupted. The end of the escape tube *d* is then allowed to dip into a vessel of cold water. This done, cold water may be readily introduced into the stage so as to cool it suddenly, by suction through the tube *c*, which must be provided with a branch (not shown in the fig.) between the clip and the stage for the purpose. To effect a sudden rise, all that is necessary is to open the clip.

An excellent contrivance for maintaining a constant temperature with a hot stage, is that devised by *Prof. E. A. Schäfer*,§ on the model of the

* Panum is also stated (Thanhoffer, tom. cit., p. 89) to have adopted the same plan as Sachs of enclosing the whole Microscope, but we have not been able to find the reference to his description.

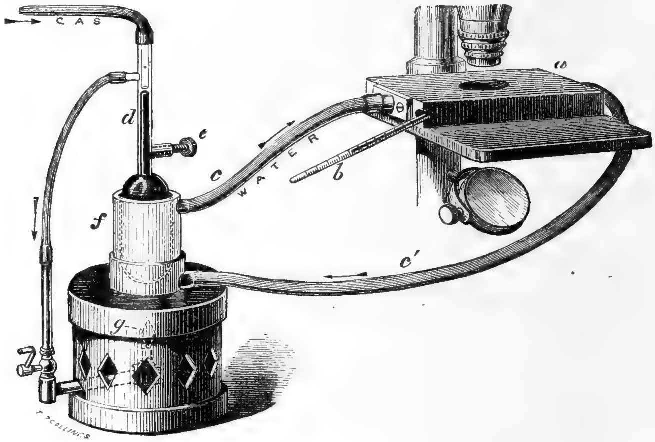
† Op. cit., pp. xx.–xxi.

‡ Burdon-Sanderson, op. cit., pp. 7–8.

§ Op. cit., pp. 22–3 (1 fig.).

ordinary gas Thermo-regulator. The object (fig. 80) is placed upon the warm stage *a*, which consists simply of a brass box resting upon the stage of the Microscope, and with a tubular aperture in the centre to admit light to the object. The box is connected by indiarubber tubes with a hollow metal jacket *f*, and the whole system thus constituted is completely filled with water previously boiled to the exclusion of air. The water is warmed at *g* by a small gas-flame and rising through the tube *c* communicates its

Fig. 80.



heat to the box *a*, the temperature of which is measured by a small thermometer *b* inserted through an obliquely placed tube quite into the central opening and immediately under the preparation. The cooled water from the stage passes down the tube *c′*, and so to the flame again, and in this way a constant circulation is kept up.

The bulbed tube *d* filled with mercury serves to regulate the flow of gas so as to keep the temperature constant at any desired point. This is effected by turning the steel screw *e* when this point, whatever it may be, is reached, so as to raise the mercury in the glass tube, and almost block up the lower end of a small steel or glass tube which is fixed into the upper end of the tube *d*. The gas used for heating passes through the small tube and then above the mercury and between the two tubes to be conducted by the side-piece to the burner below. If now the temperature rises higher in the reservoir *f* surrounding the mercury the latter will expand and rising in the tube will cut off more of the gas, and thus reduce the flame, on which the mercury will again contract and the flame increase in consequence, and so on. It is found that an equilibrium soon becomes established, and the temperature of the water and stage remains almost absolutely constant. To raise or lower the temperature all that is required is to screw *e* out or in. The smaller tube enclosed in *d* is pierced with a minute aperture to allow a constant passage of gas, so as to prevent the flame from being extinguished in the event of the mercury completely blocking up the lower end of the tube.*

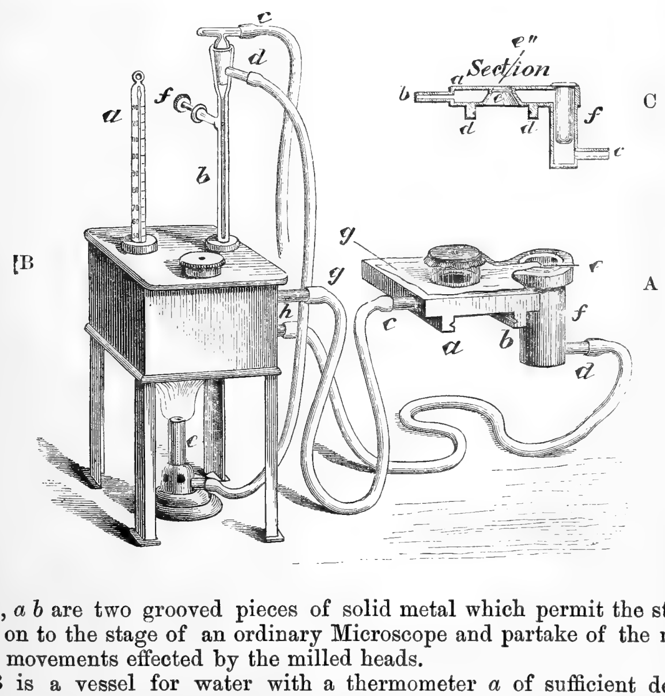
* To provide against the danger resulting from accidental extinction of the gas, Prof. Koch devised a self-acting apparatus, which, simultaneously with the extinction of the flame of the burner, shuts off the supply of gas. Cf. Crookshank's 'Practical Bacteriology,' 1886, p. 36 (1 fig.).

Dr. Dallinger's Thermostatic continuous Stage is constructed on the same principle as the preceding. It was devised for the continuous observation under high powers of the minutest living organisms, and was used by Dr. Dallinger and Dr. Drysdale for the continuous watching of monads as described in 'The Monthly Microscopical Journal,' 1869, pp. 97 *et seq.* The primary object was to arrange the field of observation, consisting of a minute drop of a septic fluid containing a given organism under observation, so that it might be observed with the highest powers, uninterruptedly, and yet that the drop of fluid should not be suffered to evaporate. The details of explanation as to how this was accomplished are given in the paper above referred to. It will suffice here to point out that the non-evaporation was accomplished by causing the objective and the covered drop to work in an air-tight chamber kept by capillary action constantly so saturated with aqueous vapour that the air within that chamber had, as it were, no room to receive the vapour from the covered drop on which observations were being made.

The present piece of apparatus aims at precisely the same thing, with the additional aim that the covered drop and all surrounding it shall be, and shall be static at, any temperature required. It was employed specially to investigate the life-history of a septic organism whose normal fluid was from 90° to 95° F.

The stage was made as described in the above paper, but it was made hollow and water-tight. The whole stage is seen in perspective in fig. 81.

FIG. 81.



At A, *a b* are two grooved pieces of solid metal which permit the stage to slide on to the stage of an ordinary Microscope and partake of the mechanical movements effected by the milled heads.

B is a vessel for water with a thermometer *a* of sufficient delicacy for indicating the temperature. *b* is a mercurial regulator, carefully made, but of the usual pattern; *c* brings the gas from the main; *d* conveys as

much of the gas as is allowed to escape from between the top of the mercury and the bottom of the gas delivery tube to the burner *e*. The regulation of this apparatus so as to obtain a static temperature, as is well known, is a matter of detail depending chiefly on the careful use of the mercurial screw-plug *f* and the height and intensity of the burner *e*. A temperature quite as accurate as is needed can be obtained for the purpose required.

The stage (A) is placed in position on the instrument; and two openings in this hollow stage at *c d* (A) are connected with two similar openings in the water-vessel, viz. *g h* (B). The whole is carefully filled with water and raised to the required temperature and regulated.

The manner in which it accomplishes the end desired is as follows. On the centre of the stage (A) will be seen a small cylinder of glass: this is ground at the end placed on the stage, and covered with a sort of drum-head of indiarubber at the upper end. By examining C with a lens it will be seen that a cell is countersunk into the upper plate of the hollow stage at e'', and a thin plate of glass is cemented on to this (seen also in section in the same figure). At *e* another disc of glass is cemented watertight, so that a film of warm water circulates between the upper and under surfaces of this glass aperture. A glass cup is placed in the jacketed receptacle *f* (A and C), and this also is filled with water. A piece of linen is now laid on the stage (A, *g*), with an aperture cut in its centre slightly less than the countersunk cell in which the glass disc e'' is fixed, and a flap from it is allowed to fall over into the glass vessel *f* (A and C). Thus by capillarity the water is carried constantly over the entire face of the linen. But the glass cylinder seen in A is made of a much larger aperture than the cell and the opening in the linen, and consequently a large annulus of the linen is inclosed within the cylinder. The drop of fluid to be examined is placed on the small circular glass plate and covered with the thinnest glass, the drum-head cylinder is placed in position, the point of a high-power lens is gently forced upon the top of the indiarubber through a small aperture, thus forcing the lower ground surface of the cylinder upon the linen, and making the space within the closed cylinder practically air-tight, but still admitting of capillary action in the linen. Thus the enclosed air becomes saturated.

By complete circulation the water in the vessel *e* (A) is but slightly below that within the jacket of the stage, and thus the vapour as well as the stage are near the same thermal point.

For aiding in illumination and admitting various illuminating apparatus, a large bevelled aperture *e* (A) is made between the lower and upper plates of the stage jacket which is found to supply all the accommodation needed.

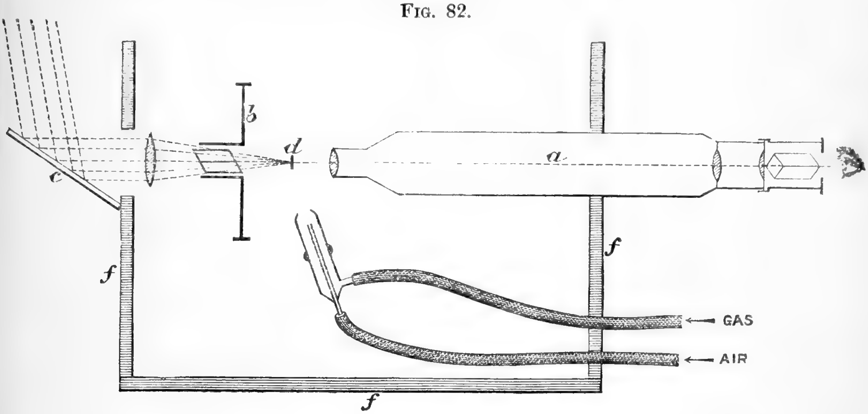
Merian's Arrangement for Heating Minerals.*—Herr A. Merian, following the researches of Mallard and Klein on the influence of heat on boracit, has studied other mimetic minerals in a similar manner. In tridymit no change of its optical relations could be perceived when the ordinary hot stage was used, and for the purpose of observing its behaviour at still higher temperatures the following arrangement was adopted.

A Microscope *a* (fig. 82) was so fixed in a box *f* that daylight could be made to pass from a plane mirror *c* through a convex lens to the nicol on the stage *b*, the Microscope being horizontal. The space between the stage and the objective was sufficiently large to allow the introduction of the preparation *d* and the heating apparatus.

* Neues Jahrb. f. Mineral., Geol., u. Palæontol., 1884, pp. 193–5 (2 figs.).

The mineral chips were supported on platinum-pointed pincers fastened to a stand, and in this way brought within the focus of a low-power

FIG. 82.



objective. By means of a small gas-jet the mineral could be brought to a white heat in a very short time, "without perceptibly warming the objective and nicol."

Capillary Tube Slide and Perforator of Cell-elements.*—One of the principal drawbacks in the microscopical examination of small objects consists in the difficulty of suitably orienting them on the slide in order to observe successively all their aspects. In observing, for instance, the segmentation of an ascidian ovum, the vitellus of which measures scarcely more than 0·1 mm., the turning round of such a delicate object demands much patience, and leads only too often to its destruction. M. L. Chabry therefore proposes the following apparatus:—

The egg is sucked into a capillary glass tube having very thin walls, and an internal diameter exactly equal to that of the egg, and measuring 8–10 cm. in length. A drop of sea-water introduced at the upper end of the tube, held vertically above the liquid, induces an internal current which drives the egg towards the middle of the tube. There is also required an ordinary slide, to which are fixed with wax two small glass sockets, at a distance sufficient to admit a cover-glass between them. These two sockets, which lie in a line following the long diameter of the slide, so exactly admit the capillary tube, that they permit no other movements than of rotation and of sliding longitudinally. That part of the tube lying between the two sockets, and containing the egg, is covered with a thin cover-glass, beneath which a drop of water is introduced. Thus submitted to microscopical examination, the object presents a clear image and its rotation is determined, even beneath the observer's eye, by the rotation imparted to the capillary tube. In order to have the latter under perfect control, one of the ends projecting over the edge of the stage is bent like the letter L.

To make it serve as a pricking, perforating, and injecting instrument, there is introduced into the capillary tube a very fine glass thread, terminated by a short, sharp point. If the end opposite that through which the stylet has been introduced be closed in such a manner as to prevent any

* Comptes Rendus Soc. Biol., iii. (1886) pp. 322–3.

escape of the liquid and of the object enclosed within the tube, the object may be pricked or perforated at any selected point by a sharp tap. If manipulated with more caution, the stylet also serves to turn the object round within the tube, and the combination of this movement with that of turning the tube permits examination in any position whatever. A lever serves to control the sliding of the stylet by reducing by five to ten times the extent of the movement imparted by the hand. This lever is a blade of straw, through the fixed end of which passes a pin fastened vertically to one of the corners of the flat slide. Its direction is perpendicular to the stylet, with which it is connected at about 1·5 cm. from its fixed end. This lever moves in the plane of the flat slide, beyond which it projects, as it is much longer than the slide is broad.

By the aid of this perforator the author has been able to pierce and kill, at will, *any* cell of an ascidian egg in segmentation, and to obtain experimentally the "monstres" called "fractions d'individu," the existence of which he discovered.

Bausch & Lomb Condenser and Substage. [*Post.*]
The Microscope, VII. (1887) p. 16 (1 fig).

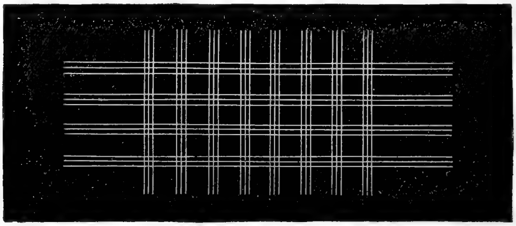
HEURCK, H. VAN.—**Comparateur à employer dans les recherches microscopiques.** (Comparator for microscopical researches.) [*Post.*]
Bull. Soc. Belg. Micr., XIII. (1887) pp. 76–8 (2 figs.).

ROHRBECK.—**Ueber Thermostaten, Thermoregulatoren, und das Constanthalten von Temperaturen.** (On Thermostats, Thermoregulators, and the maintenance of Constant Temperatures.) *Deutsche Medicinalztg.*, 1886, and *Deutsche Chemikerztg.*, 1886. Cf. *Centralbl. f. Bacteriol. u. Parasitenk.*, I. (1887) pp. 247–8.

(5) Photomicrography.

Evans's Focusing Screen for Photomicrography.*—Mr. F. H. Evans refers to the difficulty which exists in focusing, by means of an ordinary focusing lens, the microscopic image projected on a screen of patent plate glass. This is due to the power of accommodation of the eye, in consequence of which the focal plane of the image is frequently assumed to be on the outer instead of the inner surface of the screen. He suggests that this difficulty may be readily overcome by ruling on the inner surface of the glass screen (i. e. the surface towards the Microscope) a series of fine lines similar to those shown in fig. 83; the eye has then before it a definite

FIG. 83.



object in the focal plane upon which the focusing lens is adjusted, so that the almost involuntary movement of accommodation is practically arrested thereon, and the focusing of the microscopic image on that plane is thus greatly facilitated.

* Journ. and Trans. Phot. Soc., xi. (1886) pp. 25–8 (1 fig.).

BRAY, A., and R. SULZBERGER.—**La Photomicrographie.** Rapport sur la Conférence pratique de M. le Prof. Francotte. (Photomicrography. Report on the practical demonstration of Prof. Francotte.)
Bull. Soc. Belg. Micr., XIII. (1887) pp. 59–69.

FRANCOTTE, P.—**Résumé d'une Conférence sur la Microphotographie appliquée à l'histologie, l'anatomie comparée et l'embryologie.** (Summary of a lecture on photomicrography applied to histology, comparative anatomy, and embryology.)
Bull. Soc. Belg. Micr., XIII. (1886) pp. 24–56 (5 figs.).

GARRISON, F. L.—See *infra*, β (2).

HEURCK, H. VAN.—**Application du petit appareil photographique aux Microscopes continentaux.** (Application of the small photographic apparatus to Continental Microscopes.) *Bull. Soc. Belg. Micr.*, XIII. (1887) pp. 82–3.

ISRAEL, O.—**Ueber Mikrophotographie mit starken Objectivsystemen.** (On photomicrography with high powers.)
Arch. f. pathol. Anat. u. Physiol., CVI. (1886) pp. 502–14.

MERCER, A. C.—**The Indebtedness of Photography to Microscopy.**
Rep. from *Phot. Times Almanac*, New York, 1887, 7 pp.

STENGLEIN, M., and SCHULTZ-HENCKE.—**Anleitung zur Ausführung mikrophotographischer Arbeiten.** (Introduction to practical photomicrography.)
viii. and 131 pp., 5 figs. and 2 phot., 8vo, Berlin, 1887.

SULZBERGER, R.—See Bray, A.

(6) Microscopical Optics and Manipulation.

EWELL, M. D.—**Micrometric Measurements.**
[Results of measurements by six observers, showing considerable discrepancies.]
The Microscope, VII. (1887) pp. 10–2.

Glass, a New.
[Similar to the ludicrous paragraph referred to *ante*, p. 155, and contains in addition the statement that "the difference between the new and the old glass consists in the refraction of light!"]
Scientif. Enquirer, II. (1887) p. 47, from *Boston Journ. of Commerce.*

Glass, New Optical.
["The invention of a new optical glass is said to be creating a sensation in the German scientific world. The glass, owing to its great refractory power, promises to be of marked influence in practical optics, inasmuch as it will admit of the production of lenses of short focal width, such as it has hitherto been impossible to obtain. For microscopic photography it will be of the greatest importance"!]
Echo, 7th March, 1887.

H.—Measuring Refractive Index.
[G. Thompson's method. See Journal, 1886, p. 698.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 12–3.

HÖEGH, E. v.—**Eigenschaften der Jenenser Glassorten.** (Properties of the Jena glass.)
[Refractive indices and dispersive powers of forty-four kinds of glass.]
Central-Ztg. f. Optik. u. Mech., VIII. (1887) pp. 13–4.

MAYALL, J., Jun.—See Taylor, J. T.

Measurement, Minute.
[Micrometer Microscopes.] *Knowledge*, X. (1887) pp. 109–12 (3 figs.) (*contd.*)

NELSON, E. M.—**Numerical Aperture.**
[Reply to T. F. S. (p. 435), as to why an oil-immersion objective performs better than a water-immersion of the same aperture. "Accounted for by slip (loss of light by reflection, &c.) and unavoidable errors in construction."]
Engl. Mech., XLIV. (1887) p. 480.

"ORDERIC VITAL."—**Schott & Co.'s New Optical Glass.**
[Contains a translation of the list of glasses. Cf. Journal, 1886, p. 856.]
Engl. Mech., XLIV. (1887) pp. 523 and 563.

PSCHEIDL, W.—**Bestimmung der Brennweite einer Concavlinse mittels des zusammengesetzten Mikroskopes.** (Determination of the focal length of a concave lens by the compound Microscope.)
[Find the position of an object in which the given concave lens produces an image half the size of the object itself; the distance between the image and object is then equal to one-half the focal length, if the thickness of the lens be neglected.]
SB. K. Akad. Wiss. Wien, XCIV. (1886) p. 66.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XVI.**
[Ancient and modern diffraction lines.] *Engl. Mech.*, XLV. (1887) p. 1.
S., T. F.—See Nelson, E. M.
TAYLOR, J. T.—**Photographic Lenses.**
[Contains remarks on the new glass by the author, J. Mayall, jun., and others.]
Journ. Soc. of Arts, XXXV. (1887) pp. 192–201, 268–9.

(7) Miscellaneous.

A Visit to Jena.—At the January meeting of the Society, Mr. J. Mayall, jun., gave an account of his recent visit to Jena, where during about a fortnight he had been the guest of Prof. Abbe. Every facility had been given him for following the technical processes employed in the manufacture of Microscopes in Messrs. Zeiss's optical and mechanical workshops, and in the production of optical glass in the Jena Optical Glass Works, and his impression was that it would be hardly possible to overrate the skill in organization there displayed for the purposes in view. Messrs. Zeiss employed upwards of three hundred assistants in a series of workshops so arranged that those departments where delicate work was being produced —where the vibration of steam machinery would be a serious drawback— were quite separate from the departments where steam-power was employed.

Messrs. Zeiss had found it advantageous to make their own brass castings, and hence had established a foundry on their premises. He had seen the various heavy kinds of lathe-work and fraising in full operation with steam-power. The parts of the Microscope-stands where this and other mechanical work was being executed were usually given out in sets of ten, and in general the system of piecework was in vogue throughout the workshops. With regard to the optical work, only a very small portion was produced by the aid of steam-power; for instance, the plane surfaces of eye-piece lenses, which were worked together in large sets, and the glass-slitting by means of rapidly-revolving iron discs charged on the edges with diamond fragments. The glass-slitting machine was largely employed in the preparation of prisms of the different samples of glass for the determination of the refractive and dispersive indices. By means of the glass-slitter, the plates of optical glass, as received from the glass works, were cut to the various thicknesses required, and then, by means of ordinary American wheel-cutters, the thin strips were cut into squares of the sizes required. The squares were placed in suitable trays in the storeroom, whence they were given out to the glass-grinders, together with the necessary tools and the gauges belonging to them. The glass-grinders snipped the squares to approximately the disc shape, and then cemented them each on a suitable block, and ground and polished the surfaces, the metal tools being attached to foot-lathes with vertical spindles passing through deep horizontal trays, in which the refuse emery, &c., was caught, and the workmen were generally seated.

For testing the accuracy of the finished surfaces, Fraunhofer's method was employed, which consisted in providing for each curvature required a pair of highly-finished standard convex and concave surfaces worked in rock-crystal, of which the radii had been accurately determined by means of a spherometer of great precision, the perfection of the curvatures being shown by the symmetrical formation of Newton's rings when the surfaces were pressed in contact. Each surface, as finished, was tested by contact with the corresponding standard surface of rock-crystal, and the polishing was continued until the required degree of accuracy was reached. He was previously aware that Fraunhofer had employed this method of testing the accuracy of spherical surfaces for telescopes, using standards made of glass. Prof. Abbe informed him that Dr. Hugo Schröder had

suggested the advisability of making the standards of rock-crystal, instead of glass, for testing Microscope lenses, on the ground of its much greater durability where required to be in such constant use. Each workman was also provided with a contact-measurer, by which he was able to determine the thickness of the lenses, and thus approximate to the required thickness within a small fraction of error. An experienced foreman superintended this department, and was responsible for the accuracy of all gauges, &c. Mr. Mayall said he had been much interested to see these methods of precision in regular daily use in Messrs. Zeiss's workshops, the more so from the fact that for much of the optical work lads were employed, who thus obtained admirable training for the more difficult branches on which they entered later on. He had also witnessed the processes of centering the separate lenses, and reducing them to the required diameters; then the cementing into combinations and the mounting in metal cells, with its attendant further process of centering. He had also watched the whole process of manufacturing a front lens for an apochromatic 1/8 homogeneous-immersion, from the grinding to the complete mounting in its cell, centering, &c., the lens being somewhat greater than a hemisphere, and the figure being tested in the standard concave of rock-crystal as he had previously described. The rapidity and dexterity shown throughout the execution of this delicate work had most favourably impressed him as to the high character of the training in Messrs. Zeiss's workshop, for it should be noted that the production of such work was not confined to one pair of hands, as generally obtained in England, but was being executed by several—workmen of special aptitude, doubtless, but still such as the system of training there adopted brought to the fore in sufficient number to meet the demand, even in so large an establishment. He had also observed with special attention the methods employed for testing the finished objectives; but there, of course, so much depended on the education of the eye and judgment, that he could not venture to criticize, not having himself practised with Prof. Abbe's silvered plate method. He understood, however, from Prof. Abbe that the method enabled the director of that department to give precise instructions as to alterations needed to reach a certain standard of excellence.

He must not omit to refer to the photomicrographic department, to which Dr. Roderick Zeiss had given special attention. A separate building had been erected for this purpose, and massive concrete blocks supported the installation of the electric light, projection apparatus, &c., as free as possible from vibration. Here he had seen a number of images of test objects, &c., projected on a screen by means of an arc lamp of 1200 c.p., using various objectives, from 1 in. to 1/20 in. focus. In some instances the higher degree of achromatism attained in the new apochromatic objectives was unquestionably shown, and he had no difficulty in admitting that on the whole the projection images were the best he had ever seen by artificial light. In view, however, of the extreme difficulty—impossibility he might say—of controlling the arc lamp, of maintaining a steady and equal light even for a space of one or two minutes, he thought for purposes of photomicrography it could not be commended, especially not for producing large negatives by direct projection. He had long held the opinion that the best photomicrographs were obtained by making small negatives by direct projection, negatives just large enough to exhibit the points sought to be demonstrated; if, then, it were desirable to produce a further enlargement, the small negative could be magnified by an ordinary photographic process. In this way the best photomicrographs by Dr. Van Heurck, of Antwerp, were produced, and the most difficult results, such as photographing the

higher bands of Nobert's 19-band test plate, were obtained by using sunlight.

The main purpose of his visit to Jena, however, was to submit to Prof. Abbe's examination a number of the best English objectives, whence he could accurately estimate the standpoint of excellence from which English microscopists would criticize the new apochromatics produced at Jena. In furtherance of this purpose the President of the Society and Mr. Frank Crisp had placed at his disposal the best objectives in their collections. Mr. Nelson had also requested him to select from his fine collection any objectives which he thought would worthily represent English optical work. From these collections, and sundry examples from his own, Mr. Mayall said he believed he had been able to carry out the intention of his visit to Jena; and he thought Prof. Abbe was now as vividly aware of what was meant in England by "critically good images" as possibly could obtain under the circumstances. He must, of course, mention the fact that he took with him to Jena his large Powell and Lealand Microscope and accessory apparatus. If his visit to Jena resulted in inducing Prof. Abbe to withdraw his frequently-expressed depreciation of the value of the achromatic condenser—and he had reason to believe this would be one of the practical results following upon his visit—he (Mr. Mayall) should consider his journey not wholly fruitless in advancing practical Microscopy.

Referring to the Jena Optical Glass Works, Mr. Mayall said they were under the management of Dr. Otto Schott, who appeared to have thrown his energy thoroughly into every detail of their organization, which had so favourably impressed the German Government that large official grants of money had been made in aid of the experiments suggested by him. The aim of the series of experiments had been to arrive at a knowledge of the conditions necessary for regulating the refractive and dispersive indices as far as possible with the various known substances capable of vitrification. He understood Dr. Schott to say the experience he had gained in the experiments made with the assistance of the Government—experiments which had all been carefully classified and recorded—enabled him now to undertake to furnish any kind of optical glass according to sample supplied to him. On receiving such a sample, he proceeded to analyse it both optically and chemically, and then, from his registrations of experiments already made, he was able at once to select the elements and conditions required to arrive at the same result. Moreover, the exhaustive series of experiments he had made, enabled him, within certain limits, to control the ratio of the refraction to the dispersion, so that he had not only succeeded in increasing the range between the limits beyond what had been reached previously by makers of optical glass, but was also in a position to manufacture glass of any given refraction and dispersion for special purposes. The skilful optician was thus provided with new optical means which would certainly lead to general improvements in the construction of telescopes, field-glasses, &c. The new kinds of glass employed in Prof. Abbe's apochromatic objectives were produced at these Glass Works, as also the glass employed by Messrs. Powell and Lealand for their new apochromatics. Dr. Schott expressed his conviction that several of his new kinds of glass would be found of great importance in the construction of photographic lenses; he also said that Steinheil, the well-known optician of Munich, had already adopted its use largely. Such a fact ought not in his (Mr. Mayall's) opinion to be neglected by our makers of photographic lenses; for, assuredly, if one of them could succeed in producing lenses with a given ratio of aperture to focal length, but with a larger and flatter field than

had hitherto been seen—and the apochromatic Microscope-objectives showed how advance in that direction had been made by means of the new glass—the demand for such improved lenses would be practically unlimited.

Microscopic Justice.—Under this heading the 'Evening News' of 16th March says:—"Mr. Justice Chitty's Court presents a curious scene to-day. The judge is trying a patent case relating to waterproof fabrics. The Attorney-General, Mr. Moulton, Q.C., and Mr. Finlay, Q.C., are engaged in the case, and the learned counsel are provided with Microscopes to examine the materials. Another Microscope is placed upon the judge's desk, and during the morning witnesses have been seated beside Mr. Justice Chitty peering through the Microscope to detect differences of manufacture in the fabrics."

LOEWENHERZ, L.—**Zur Geschichte der Entwicklung der mechanischen Kunst.** (On the history of the development of mechanical art.)
[Includes G. F. Brander (Glass Micrometers) and Fraunhofer (Achromatic Lenses and Microscope).]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 405–19.

MACFARLANE, J. M.—**On the Progress of Microscopical Research.**
[Presidential Address to the Microscopic Section.]
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 319–26.

MATTHIESSEN, L.—**Ueber eine neue Etagenloupe.** (On a new "tier" lens.)
[Discusses the lenses described in this Journal, 1886, p. 1065.]
Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 109–10.
See also *Nature*, XXXV. (1887) p. 331.

MAYALL, J., Jun.—**Cantor Lectures on the Microscope.**
[Reprint in a collected form of the lectures noted in Journal, 1886, p. 869.]
97 pp., 103 figs., 8vo, London, 1886.

POUCHET, C.—**Prof. C. Robin, Sa Vie et son Œuvre.** (Life and work of Prof. C. Robin, Hon. F.R.M.S.) (*Concld.*)
Journ. de l'Anat. et de la Physiol., XXII. (1886) pp. xlix.–clxxxiv.

Scientific Directory. *Sci.-Gossip*, 1887, pp. 40, 65.

Western Microscopical Club.
[Report of meeting on 7th February, 1887, with system of classification of Mr. Crisp's Collection of Microscopes, &c.]
Engl. Mech., XLIV. (1887) p. 539.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

ESMARCH, E.—**Ueber die Reincultur eines Spirillum.** (On the pure culture of a *Spirillum*.) [*Post.*] *Centralbl. f. Bacteriol. u. Parasitenk.*, I. (1887) pp. 225–30.

PETRI, R. J.—**Eine kleine Modification des Koch'schen Plattenverfahrens.** (A small modification of the Koch plate process.) [*Post.*]
Centralbl. f. Bacteriol. u. Parasitenk., I. (1887) pp. 279–80.

SMITH, T.—**The relative value of cultures in liquid and solid media in the diagnosis of bacteria.** *Med. News*, 1886, II. pp. 571–3.

(2) Preparing Objects.

Preparing Goblet-cells.†—Dr. J. H. List examines goblet-cells, if possible, in aqueous humour, iodized serum, and 0·5 per cent. salt solution.

As isolation media, excellent results were obtained from Müller's fluid after acting for several weeks, from 0·5 per cent. osmic acid in 24 hours, followed by teasing out in distilled water or dilute glycerin (equal volumes of glycerin and distilled water), and from 0·1 per cent. chromic acid in

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 481–588 (6 pls.).

one or two weeks. He also used one-third alcohol for 24 hours, followed by staining with rosanilin nitrate or dilute Renaut's hæmatoxylin-glycerin, to show the granular circle round the nucleolus of the goblet-cell nuclei in the bladder of various amphibia. The best results were obtained from sections. The objects were either placed for some days in Müller's fluid and then hardened successively in 50, 70, 90, and 100 per cent. alcohol, or were left in 0·5 per cent. osmic acid for 24 hours and then hardened gradually in spirit. But excellent results were also given by 2 to 3 days' hardening in 0·25 per cent. chromic acid, followed by washing in water for 24 hours, and this by gradual hardening in spirit, or by a 24 hours' action of Flemming's chrom-osmium-acetic acid, and after hardening in spirit. The objects were imbedded in celloidin, then cut and stained in the manner previously described,* although it may be mentioned that rosanilin nitrate and Weigert's Bismarck brown are excellent for the purpose. The sections were overstained, and the excess of colouring matter extracted in absolute alcohol, and then after dehydration and clearing up in bergamot oil, were mounted in balsam or dilute glycerin. For the connections between the goblet-cells and nerve-terminations, a 0·5 per cent. gold chloride solution was used after Ranvier's method.

Preventing Cartilage-cells shrinking away from Matrix.†—Mr. B. L. Oviatt states that Prof. Gage finds that the following mixture is superior to the saturated solution of picric acid, recommended by Ranvier for preventing cells shrinking away from the matrix: Picric acid, 7·5 grns.; alcohol (95 per cent.), 250 c.c.; water, 250 c.c. After 24 hours the sections are transferred to water, wherein they remain for 6 to 12 hours.

Demonstrating the Nuclei of Mammary Gland-cells in Lactation.‡—Dr. F. Nissen used as his material the glands of suckling bitches, rabbits, and cats. The animals having been killed by cutting their throats, the glands were quickly removed and cut into small pieces, some of which were placed in a concentrated sublimate solution heated to 40° C., and others in Flemming's chrom-osmic-acetic acid mixture. After twelve hours the pieces from the sublimate solution were washed in flowing water for twenty-four hours, and then hardened in alcohol. When sufficiently hard they were passed for twenty-four hours into a one per cent. watery solution of logwood, and thereupon for another twenty-four hours into a one per cent. alum solution (changed five or six times). In order to obtain a pure nuclear stain, the colour must be extracted with the alum solution until the extraction fluid is but little tinged. The protoplasm is either unstained or has merely a faint bluish reflex, the chromatin of the nucleus alone is stained; the connective tissue is unaltered, but the lymph corpuscles are deeply dyed, so that by the degree of stain they are easily discriminated from the nuclei of the alveolar epithelium. The coloured pieces were dehydrated with absolute alcohol saturated with turpentine oil, imbedded in paraffin and cut with a microtome. The pieces kept in Flemming's mixture were after two or three days washed for twenty-four hours, hardened in absolute alcohol, and imbedded unstained in paraffin. The sections were freed from paraffin by means of turpentine, and the turpentine removed by alcohol.

Gram's method was used for staining. The staining fluid is a solution of 3 grms. anilin, 1 grm. gentian violet, in 15 absolute alcohol, with addition of 100 grms. of aq. dest. When removed from alcohol the sections are

* See this Journal, 1885, p. 902.
† St. Louis Med. and Surg. Journ., li. (1886) p. 209.
‡ Arch. f. Mikr. Anat., xxvi. (1886) pp. 337–42 (1 pl.).

placed from 3–5 minutes in this solution, then washed for a few seconds in absolute alcohol, and then transferred to the iodide solution, which is—1 part iodine, 2 parts iodide of potassium, and 300 parts water. They are finally decolourized in absolute alcohol, cleared up in oil of cloves, and mounted in Canada balsam.

Artificial Distortions of the Nucleus.*—Dr. C. Van Bambeke employed principally the intestinal canal and Malpighian vessels of Arthropoda in his researches. The organs or their parts taken from the living animal were teased or spread out. Organs of tubular form, like the intestinal canal, were first of all split up and their contents evacuated. The blood of the animals could be examined without the aid of reagents; yet it was more advantageous to add a fixative and a staining medium. The author preferred acid methyl-green, under the influence of which reagent the nuclei of the eyes and their alterations could be easily studied. For permanent preparations, fixation with osmic acid, staining with methyl-green, and mounting in dilute glycerin were employed.

The manipulation to which the organs were exposed produced alterations in a large number of nuclei, and this alteration occurred also in various proportions, according to the species examined.

Demonstration of the Fibrillæ of Unstriated Muscular Fibres.†—For demonstrating the longitudinal fibrillation of unstriated muscular fibres the following method has proved very satisfactory according to Prof. S. H. Gage: Ten to fifteen cm. of perfectly fresh small intestine from a cat or other animal is tied at one end, and into the other is injected the following mixture: 95 per cent. alcohol 25 c.c., water 75 c.c., picric acid crystals 3/4 gram. When the intestine is moderately distended, the end in which the injection is made is tied, and the piece of intestine placed in a glass dish and covered with the mixture. After one or two days the muscular coats may be torn off in shreds. If one of the shreds is teased well with needles, unstriated muscular fibres may be partly or wholly isolated. They may be mounted in 75 per cent. glycerin. The picric acid stains the fibres yellow, and with a homogeneous-immersion (1/12 or 1/18) the longitudinal fibrillation shows with the greatest clearness. In some cases the ends of the fibres will be frayed, and show the fibrillæ something like a brush.

Preparation of the Organs of the Nervous System.‡—Prof. G. Golgi's improved method is as follows:—

1. Combined use of bichromate of potash and nitrate of silver. This depends on the gradual removal of the bichromate from the hardened pieces by means of a half to 1 per cent. solution of silver nitrate. The reaction is completed in 20 to 30 hours. This method is somewhat uncertain. 2. Successive use of bichromate of potash, osmic acid, and silver nitrate. Hardening is effected in a mixture of a 2 per cent. solution of bichromate, 8 parts, and 1 per cent. solution of osmic acid, 1 part. The pieces, which must be very small, are then immersed in the silver nitrate solution. 3. Successive action of potassium bichromate and perchloride of mercury. This method requires from one month to a year (according to the size of the pieces) for its full development, but a whole brain may be stained through at once.

Preparation of Amphibian Embryos.§—Dr. C. Rabl recommends that the embryos of *Salamandra maculosa* and *atra* and *Triton tæniatus* should

* Arch. de Biol., vii. (1886) 3 pls.

† The Microscope, vi. (1886) pp. 267–8.

‡ Milano, 1886. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 409–10.

§ Morphol. Jahrb., xii. (1886) pp. 252–7 (2 pls. and 2 figs.).

be fixed in 1/4 to 1/3 per cent. platinum chloride solution for from 3 to 24 hours, according to size. Then, having been carefully washed in water, they should be transferred to weak spirit and afterwards to stronger alcohols. Sections should be stained on the slide.

Preparation of Eggs of Osseous Fishes.*—Dr. M. v. Kowalewsky hardens eggs of *Carassius auratus* L., *Polycanthus viridiauratus* L., and *C. auratus* L. var. for $1\frac{1}{4}$ hours in a mixture of picro-sulphuric acid 8 vols., 1 per cent. chromic acid 1 vol. The eggs of *Carassius* were placed in the foregoing along with the pieces of plants to which they adhered, because they could not be separated therefrom without damage. The hardened eggs were then transferred to 20 per cent. spirit, frequently changed, for about 12 hours, and then in the course of 10 hours passed through 20, 28, 35, 43, 50, 60, and 70 per cent. spirit, in the last of which they were preserved. Before staining, the egg-sac was ruptured under a dissecting Microscope. The stain was either Grenacher's borax-carmine, or hæmatoxylin, then toluol and paraffin.

Preparation of Heart-muscle in Cardium edule.†—Dr. K. Drost used the following maceration medium introduced by Möbius:—Chromic acid 0·25 per cent., osmic acid 0·1 per cent., acetic acid 0·1 per cent., in sea water. In this fluid the objects remained for some days; acids by themselves gave no results.

For *Montacuta bidentata* 1 part sea-water to 0·5 per cent. bichromate of potash 4 or 6 parts were used; but the hairs of the sense-organs were found to be macerated.

Preparation of Eggs of Arthropoda.‡—Dr. F. Stuhlman in the examination of the eggs of insects, spiders, Myriopods, and *Peripatus*, examined fresh objects in 0·75 per cent. salt solution, to which is sometimes added weak acetic and methyl-green acetic acid. The foregoing was only suitable for young eggs, as older ones are too opaque. As fixative, cold concentrated sublimate solution proved the best. Water, 33 per cent. alcohol, and hot sublimate solution were not so useful. The cold sublimate fixed in 5 to 10 minutes. The preparations are then thoroughly washed; a few drops of tincture of iodine hastened the process. Then 60 per cent. spirit and finally absolute alcohol. The chorion is perforated with a fine needle, but the upper-pole is to be avoided. Ovaries are placed for several hours in chloroform, then from one to three days (according to size) in paraffin at about 55° C. The imbedding mass is rapidly cooled. The sections are stuck on with a thin layer of Mayer's fluid. The author states that fresh albumen mass stains less easily than the older. The stains used were Grenacher's borax-carmin, Weigert and Ranvier's picrocarmin, and Flemming's hæmatoxylin. The author recommends double staining with picrocarmin and hæmatoxylin; weak staining first with picrocarmin and afterwards with the logwood. The dye is then extracted with acidulated alcohol until a red hue appears, the sections are then transferred to ammoniacal alcohol until the blue colour reappears. In order to obtain various shades of colour the author advises to stain about 3/4 of the sections (*sic*) with picrocarmin and then to draw out the slides from the fluid so that the upper part is more deeply stained than the lower. The slide is then turned round and the process reversed with hæmatoxylin. Afterwards absolute alcohol, bergamot oil, xylol balsam,

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 434–80 (1 pl.).
† Morphol. Jahrb., xii. (1886) pp. 163–201 (1 pl.).
‡ Ber. Naturf. Gesell. Freiburg i. B., i. (1886).

Flemming's chrom-osmium-acetic acid, and safranin staining give good results. Fixation with 3 per cent. nitric acid produced vacuoles in the yolk, and was, therefore, of but little use.

Preparation of the Embryo of the Fresh-water Crayfish.*—Dr. H. Reichenbach hardens the eggs by placing them in water, which is gradually heated up to 60° or 70° C. (rupture of the chorion does not damage the embryo); they are then hardened in a 1 to 2 per cent. bichromate or 0·5 per cent. chromic acid for 24 hours; next washed for a similar period, and then transferred first to 70 per cent. spirit and lastly to absolute alcohol. The chorion is then opened, and the embryo separated from the yolk by means of a sharp knife, and stained with picrocarmin. The yolk stains yellow, the plasma and nuclei red; then water, alcohol, cloves, and balsam.

Preparation of Copepoda.† — Dr. J. Vosseler recommends as the simplest method for killing, hardening, and staining Copepoda, to place them for about 12 hours in a mixture of Flemming's solution 1 part, water 2 parts, and then, after washing, to harden in spirit; mount in Venice turpentine. The animals also may be killed by the gradual addition of alcohol to the water in which they are contained. After having been placed in a mixture of equal parts of glycerin and water from 10 to 14 days they may be examined. Permanent preparations should be afterwards placed in absolute alcohol and mounted in Venice turpentine.

Preparation of Lumbricida.‡—Dr. H. Ude, in order to demonstrate the anatomy of the pores and the histology of the body-wall, employed the following methods:—

1. Living earthworms were placed in 0·5 per cent. chromic acid and hardened therein for eight to ten hours, washed in water, and transferred to 70 per cent. alcohol, then stained with Hamann's neutral acetic carmine, 70, 80, 90, 100 per cent. spirit, chloroform, chloroform-paraffin, pure paraffin. Results: Hypodermis good; longitudinal muscles destroyed.

2. The worms were killed in boiling water and the bodies, stretched on cork, were then treated for eight hours with 1 part concentrated picro-sulphuric acid to 3 parts distilled water. After washing they were stained with Grenacher's borax-carmine. Results excellent, but if the colour be withdrawn with hydrochloric acid alcohol the cuticula and hypodermis are damaged.

3. If the animals are to be preserved in spirit they are previously narcotized with chloroform vapour, in order to prevent too great contraction. Stain with borax-carmine.

Preparation of Rhabdocœlous Turbellaria.§—Dr. M. Braun prepares whole specimens on a slide by running under the cover-glass a mixture of 3 parts Lang's fluid and 1 part of a 1 per cent. osmic acid solution. Directly the animals become opaque the superfluous fluid is removed with blotting-paper, and then replaced by 45 per cent. spirit and afterwards by 70 per cent. alcohol. The cover-glass is then removed, and 96 per cent. alcohol applied. In a few minutes the latter is replaced by 1 or 2 drops of alum-carmine which stains in 2 or 3 minutes. Wash in water, transfer to alcohols of gradually increased strength up to absolute; clear up in oil of cloves or creosote, and mount in balsam.

* Abh. Senckenb. Naturf. Gesell., xiv. (1886) 137 pp., 14 pls.
† Inaug.-Diss. Stuttgart, 1886. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 400.
‡ Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 87–143 (1 pl.).
§ Arch. Naturk. Liv.-Esth. u. Kurlands, x. (1885). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 398–9.

If the animals are to be sectioned the author uses Lang's fluid boiling, or the before-mentioned mixture of Lang's fluid and osmic acid. After 5 minutes the fixative is removed, the object washed with water and treated with alcohol. In two days the staining may be done. Imbedding is made in a mixture of ordinary paraffin, tallow, and hard paraffin (about 1/10 of the mass). The latter imparts a consistence suitable for riband sections.

Preparing Diatoms in Cementstein.*—Mr. H. Morland recommends the following plan for preparing and isolating the diatoms in Jutland "cementstein":—

Slices about 1/25 in. in diameter are first of all prepared with "Wellington knife-powder." When the slice is finished on one side, it is attached with balsam, prepared slide downwards, to the slip on which it is finally mounted. The balsam for this purpose must be hard, and it is necessary to avoid bubbles under the section. The slices are fixed with balsam slightly hardened, and then hardened off gradually by placing the slips in a very cool oven for a week or ten days; the balsam is thus hardened throughout without bubbles. The second side of the slice can now be rubbed down in the same way as the first side with "Wellington knife-powder" and water on glass. As the section approaches completion, care and very light pressure must be employed, the grinding being continued until the section begins to break away at its edges. The slip with section attached is now washed with clean water, wiped, and dried off with a very gentle heat, not sufficient to soften the balsam. A very small quantity of balsam is now put on the section, the cover placed on, and pressed down hard. The slide is now placed in a cool oven for a few days. A ring of Bell's cement will enable it to be examined under an oil-immersion lens without fear of the oil attacking and softening the balsam.

In order to isolate the diatom sections, after preparing one side of the slice, it is attached to a piece of glass about $1\frac{1}{4}$ in. by 1 in. instead of the ordinary 3 in. by 1 in. It is then immersed, still attached to the glass, in benzol. After about half an hour it can be brushed off with a camel's-hair pencil on to a glass slip, and cleaned of all balsam by brushing with the camel's-hair pencil dipped in benzol. The slide is then transferred to methylated spirit to get rid of the residue of benzol, and, after a short time, to clean water in a watchglass. The water is poured off and a few drops of hydrochloric acid added, which at once separates the diatoms contained in the section. The watchglass is now filled up with distilled or filtered rain-water, allowed to settle, the liquid drawn off closely by means of a fine pipette, and filled up with water again; the process being repeated until the whole of the hydrochloric acid has been got rid of. The diatoms in the watchglass are now boiled in sulphuric acid; and after washing away the acid, the clean diatom sections are ready for selecting and mounting. Mr. Morland states that some of his sections prepared in this way are not more than 1/3000 in. thick.

Preparing Tubercle Bacilli.†—Herr Biedert dilutes 1 tablespoonful of sputum with 2 of water and 15 drops liquor sodæ, and then boils to fluidity; 4 spoonfuls of water are again added, and the fluid reboiled until it is of uniform density. If on cooling it does not run well, more water is added; the fluid is kept bottled for two days, and then the supernatant liquid poured off so as to leave a quantity 5–8 mm. high in the flask. To this some fresh egg-albumen is added, and after having been well shaken together the fluid is used for cover-glass preparations.

This method was found to give considerable increase to the number of

* Journ. Quek. Micr. Club, ii. (1886) pp. 299–301.
† Berliner Klin. Wochenschrift, 1886, Nos. 42–3.

bacilli over those found in the original sputum. The Ehrlich and the Neelsen-Johne methods of staining were used.

If the alkalized fluid were allowed to stand longer than two days, and if more than fifteen drops of caustic soda were added, the number of bacilli diminished. From these facts, it is naturally concluded that the non-staining is due to the alkali, and the author recommends for his procedure the Neelsen-Johne method, as he found that Ehrlich's stain was less reliable. The foregoing method is inapplicable for the demonstration of *Bacillus tuberculosis* in tissues.

BRYAN, G. H.—**On mounting selected Diatomaceæ.**
Scientif. Enquirer, II. (1887) pp. 48–50.

CERTES.—**Procédé de M. Tempère** pour le montage dans le baume des organismes microscopiques délicats et pour fixer directement des Infusoires par certaines couleurs d'aniline. (Tempère's process for mounting in balsam delicate microscopic organisms and for immediately fixing Infusoria by certain anilin colours.) [*Post.*]
Bull. Soc. Zool. France, XI. (1886) pp. xix.–xx.

Fraenkel, E., and Simmonds, M.—**Preparing Sections containing Typhoid Bacillus.**
Scientif. Enquirer, II. (1887) p. 32. *Transl.* from 'Die Ætiologische Bedeutung des Typhus Bacillus,' Hamburg and Leipzig, 1886.

GAGE, S. H.—**Notes on Microscopical Methods.**
iv. and 32 and 4 pp., 11 and 2 figs., 8vo, Ithaca, N.Y., 1886–7.

GARRISON, F. L.—**The Microscopic Structure of Iron and Steel.**
[Methods used in preparing the specimens. Microscopes. Use of photography.]
Journ. Franklin Institute, CXXIII. (1887) pp. 181–95 (2 pls. and 1 fig.).

GOODALE, G. L.—**A Method for subjecting living Protoplasm to the action of different liquids.** [*Post.*] *Amer. Journ. Sci.*, XXXIII. (1887) pp. 144–5.

L[ATHAM], V. A.—**Preparation of Diatoms.**
[Prof. Brun's process.] *Scientif. Enquirer*, II. (1887) p. 31.

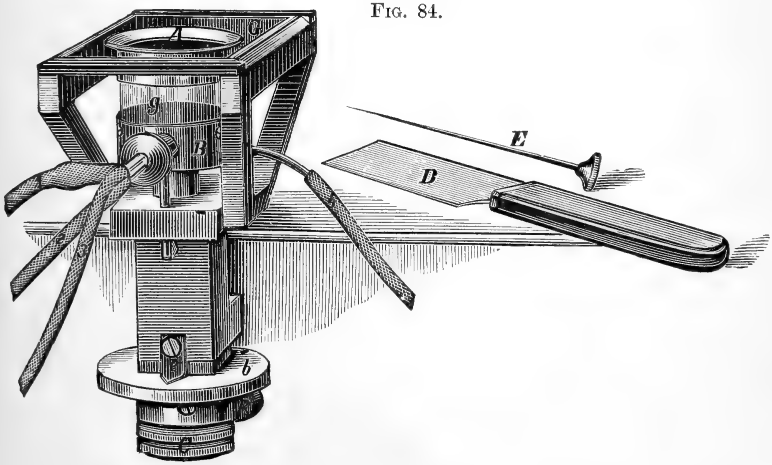
MOORE, A. Y.—**Mounting whole Insects.** *The Microscope*, VII. (1887) pp. 13–5.

SCHULZE, F. E.—**Ueber die Mittel welche zur Lähmung von Tieren dienen können, um dieselben im erschlafften ausgedehnten Zustande erhärten oder anderweitig konservieren zu können.** (On the means of paralysing animals in order to harden or otherwise preserve them in a relaxed and extended condition.) [*Post.*]
Biol. Centralbl. VI. (1887) pp. 760–4 (*Ber.* 59 *Versamml. Deutsch. Naturf. u. Aerzte*, Berlin, 1886).

(3) Cutting, including Imbedding and Microtomes.

Jung's Freezing Microtome.—This instrument (figs. 84 and 85) is constructed on the lines of the apparatus devised by Hughes and Lewis.

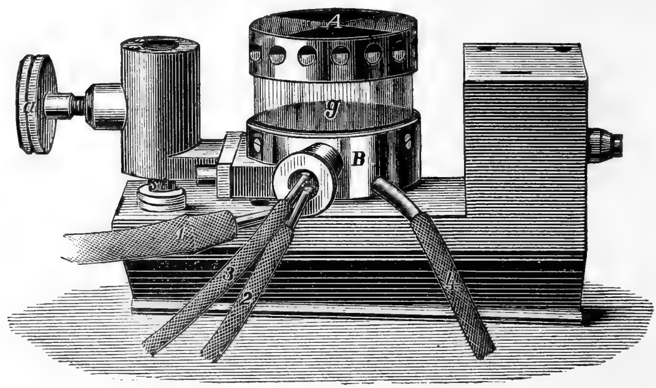
FIG. 84.



By making the tube *g* of mica, the object is found to retain the cold much longer than is the case with other constructions. A is the plate on which the preparation is laid; *g*, the mica cylinder; B, the lower part in which the ether spray tubes are fixed. No. 1 tube is from the bellows; No. 2 takes the air to the ether bottle; No. 3, the ether bottle spray point; and No. 4 is the overflow pipe for the excess ether.

The glass plate G serves as a support for the knife; *b* is divided in order to determine the thickness of the sections (1 division = 1/200 mm.);

Fig. 85.



C is the micrometer-screw which raises the object; R is the screw which fastens the instrument to the table; D is the ordinary form of knife, and E a stilet for clearing the spray points without enlarging their openings.

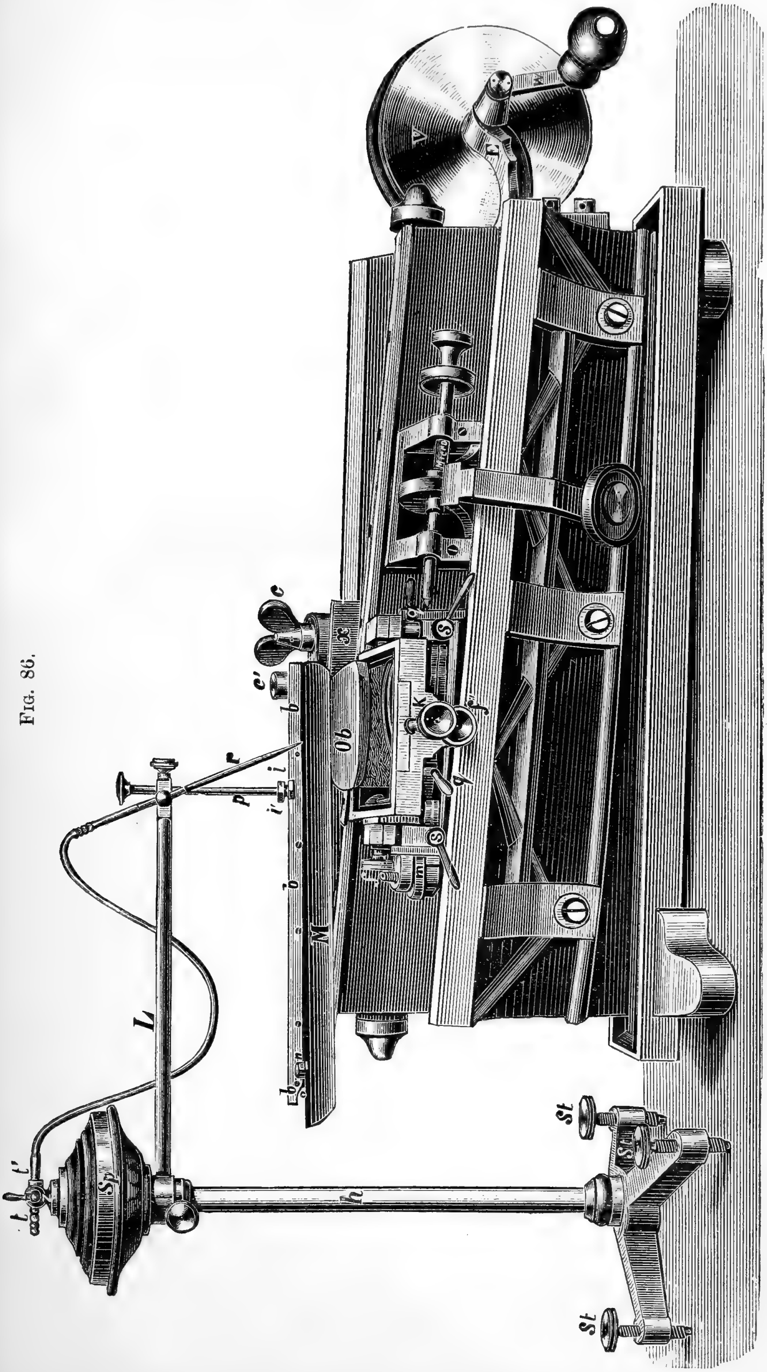
Fig. 85 shows a similar contrivance adapted for use with a slide microtome.

Jung's Sliding Microtome for very large objects.—As this microtome of Herr R. Jung (fig. 86) corresponds in the construction and use to the smaller instruments, it is only necessary to describe the provision for cutting large objects.

The knife is to be placed considerably higher in front than behind, in order to lessen the pressure on the objects. In order to satisfy all demands, the knife-rest is adjustable. The knife is so arranged that the whole length of blade can be used, and then the screw *c* is fairly tightly screwed down. As strong knives, even of a length of 36 cm., easily give, a knife-support has been constructed; this is fastened by the screw *c′* to the carrier. The support is arranged parallel with the back of the knife M; if the extremity *n* be slightly pressed backwards so that it touches the knife, it is then fixed in this position by the screw *o* (scarcely evident in the illustration).

This done, the spirit-vessel *Sp* can be arranged in a position which will not interfere with the free movement of the knife. In order that a stream of spirit may follow the knife over the object, the following arrangement is adopted. The spirit-vessel *Sp* turns round an axis on the column *h*; to it is joined the arm L, which carries in front the fine tube *r* (connected with *t t′*), and also the rod *p*; the latter is movable perpendicularly, and to its lower end a bridge or grip with two small rollers *i* and *i′* is fastened. The rod *p* is so placed that on each side of the metal strip *b*, screwed on to the

Fig. 86.



Jung's Sliding Microtome for very large objects

knife-support, there is one of the rollers. By the adjusting-screws *St* the whole apparatus is so arranged that, when the knife-carrier is in motion, no other friction occurs than that of the rollers on the strip *b b b*.

The vessel is filled by screwing off the head Z. As the tube *r* acts as a siphon, it is necessary when the cock is turned on to blow down the tube. The stream of spirit should be directed at a right angle to the knife, and about the middle of the object. This done, the object *Ob* by means of the screw *k* is firmly grasped in the fangs of the object-carrier; the correct direction for the position of the knife is given to its surface by the screws at *f* and f_1, and then the axes of the fangs are tightened up by the levers *q* and *q'*. If the height of the object is not quite correct, adjustment is made by the screw *m*. By turning the screws *s s* the holder is fixed.

V is a wheel with cranked axle *Ew*, and this by means of a catgut band moves the knife.

Microtome used at the Naples Zoological Station.—This instrument in its improved form (figs. 87, 88, and 89), is described by Herr R. Jung.*

(1) *The knife and its carrier.*—The knife, which is plano-concave, is pushed into its holder *a* (fig. 88), and fixed by means of the two screws *b* at both points. The holder is in its turn fastened to the carrier by means of two bolts *c*, and these are screwed up by inserting the rod *d* in one of the five holes (cf. fig. 87). If the knife is to rest on the carrier directly, the shorter bolt is used; if, on the contrary, the object to be cut is very long, it becomes necessary to raise the knife, and one, two, or three metal plates having been placed underneath, the long bolt is used. The choice of the screw depends on the form of the object and the position of the knife. The latter, in virtue of the construction of the holder, can be used in any position, and along its whole length. For large objects of unequal texture, it is recommended to place the knife as far as possible in an almost parallel position (cf. fig. 88), and to move the carrier slowly and carefully. In this way such objects are cut to the best advantage. If, however, the object be small and of similar consistence throughout, the knife may be placed in front and the section made by a planing motion. The paraffin block which incloses the object must be so arranged that the anterior and posterior edges of the section are parallel, and also at right angles to the middle vertical plate of the instrument; in this way, with quick planing, the sections stick together, forming large bands.

Before the knife is sharpened or stropped it is fastened to the handle, and a steel case is pushed up over its back and screwed up. In most instances one turn on a good strop suffices, and this should be done without any force.

(2) *The section-stretcher.*—In its new form this can be used for any position of the knife, and is easily applied thereto. The long rod *e* (fig. 88), partly with the hand, partly by means of the two screws *f*, is accurately adapted, parallel to the surface, and in such a way that it projects over the edge; it is then lowered by the front screw *g*, until almost in contact with the knife-surface. For small objects the slender, for large, the thick rod is used. If the sections are very bulky, the tendency to turn up must be prevented by pressing lightly on the section with a spatula, &c., as it appears between the rod and the blade. If the section-stretcher be properly arranged it works perfectly trustworthily, provided the sections have no tendency to crumble. When the knife is placed obliquely, the paraffin block is best shaped as a right-angled triangle, so disposed that the knife-

* Preis-Verzeichniss, 1886, pp. 16–9 (3 figs.).

FIG. 87.

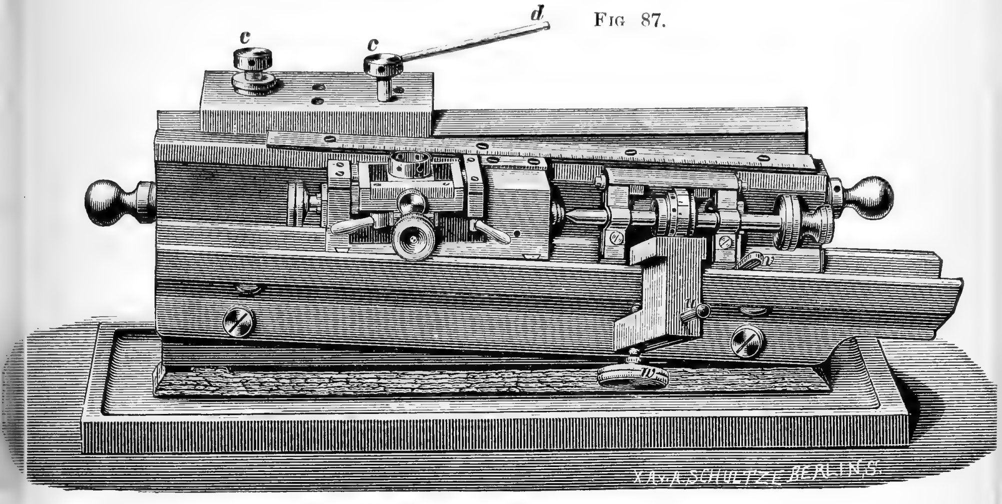


FIG. 88.

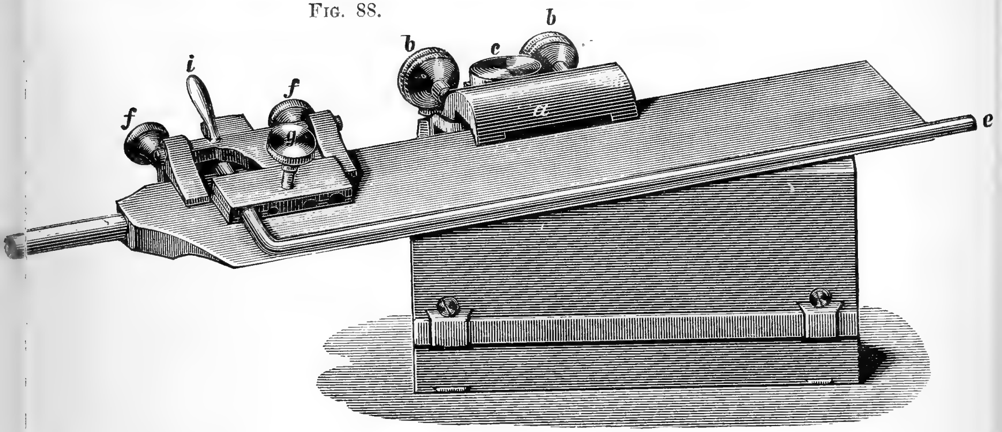
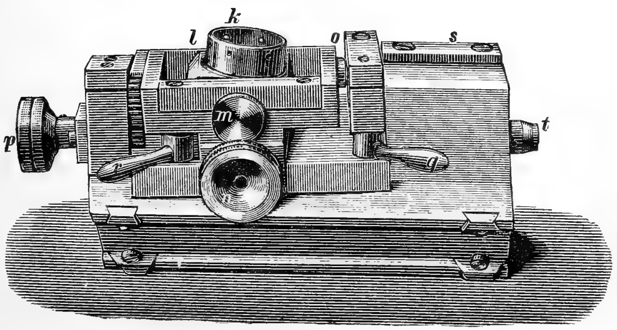


FIG. 89.



MICROTOME USED AT THE NAPLES ZOOLOGICAL STATION.

blade touches upon one of the two tangential sides and finally reaches the opposing angle. When the knife is placed across or in front the section-stretcher is usually superfluous, and the block must have the shape given above (under No. 1). The handle *i* serves to remove the rod for cleaning it or the knife-surface.

(3) *The object-carrier.*—The hollow cylinder (*k*, fig. 89) serves for the reception of the object to be cut. For this purpose it is filled with hard paraffin; in this last the paraffin block, in which the object is imbedded in the usual way, is melted with hot needles. The cylinder, by the aid of the small pin *u* (fig. 87), which fits the holes, is capable of vertical and horizontal movement, and is fixed by means of the screw *m*; by the milled head *n* the direction may be altered to the extent of 90°, and the metal frame can receive through the milled head *n* a similar inclination to the plane standing vertically to it. In this way the object may be placed in any desired direction to the knife-edge. The two levers *q* and *r* serve to fix it. Too strong pressure should be avoided, as the plates may be bent thereby.

(4) *The micrometer-screw.*—The object-carrier can be moved along by the hand, and for the accurate estimation of the amount of movement there is a vernier which corresponds with the millimetre scale on the vertical upright of the microtome. It is, however, safer to use the micrometer-screw (fig. 87) the point of which works against an agate. The screw is so threaded that one turn moves the carrier up 0·3 mm., consequently an upward movement of 1:20 produces an ascent of the object of about 0·015 mm. The screw-head is divided into fifteen parts, and therefore the interspace between any two divisions corresponds to an elevation of 0·001 mm. If by means of the pin *u* the movable half of the cylinder be shifted so that the numbers V, X, XV can be read, a click, produced by a spring, will be heard fifteen times at every revolution of the screw. If the two numbers 3 on the side of the cylinder be approximated, the clicking only occurs thrice; therefore each one corresponds to a raising of the object 0·005 mm. Similarly for 2 and 2 or 1 and 1, the values 0·0075 and 0·015 mm. are obtained. The spring-catch arrangement may be dispensed with by raising the handle *v*. The screw-carrier is fixed to the groove by the milled-head *w*.

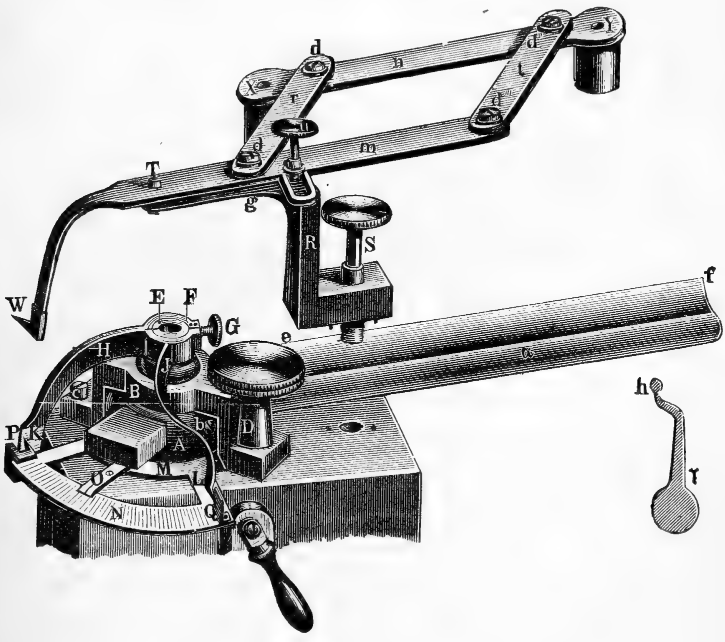
Apparatus for controlling the position of the Microtome Knife.*— Dr. T. v. Dembowski's contrivance consists of two distinct parts. In the first of these the knife *a* (fig. 90) is fixed by the ball-and-socket joint A, the ball of which lies in a hollow excavated in the upper surface of the slide. The arch B covering the ball is fixed by the screws *c* and D. From above B projects a short tube E, which forms part of the ball. Inside the tube E is a binding-screw, accessible through the opening; another, *b*, is seen at the side. Fitting over E, and fixed by the screw G, is another tube F, with two arms H and J. At the end of H is a scale K, and at the end of J a pointer L; the latter is at right angles to K. Encircling the excavation in the slide is a wall-like ring, about which the plate M turns; at the end of this plate is a pointer P. The other end of M carries a vertically placed plate Q, provided with a scale. The end of the pointer P is distant about 90° from Q, so that when the pointer P touches the scale K the point L is brought into contact with the plate Q. The pointer O indicates on the scale N what angle the edge must form with the middle plane of the microtome in order to be able to cut objects of given size when using the whole length of the blade.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 337–45 (2 figs.).

The second part of the apparatus (which in fig. 90 is raised above its ordinary position for the purpose of rendering its parts more conspicuous), consists of a plate R, fixed to the slide by the screw S and two pegs. From R projects, over the ball-joint, the piece *g*, to which is applied the bar *m*, fixed by a screw *u*. Through *m* and *g* the screw-peg T passes to be inserted in the centre of the ball-joint. The left end of *m* terminates in the pointer W, and this is so situated that it points to the same division of the scale K as P does.

The pieces *r n t m* form a parallelogram, with movable joints at *d d′ d″ d‴*. At the ends of *n* are the diopters X and Y, and the plane in which they lie is parallel to the plane which passes through the centre of the ball, the peg T, and the pointer W.

FIG. 90.



To the right of the lower part of the illustration is the piece γ, which is fixed to the object-carrier, and bears at its free end the knob *h*. This piece and the knife are so arranged that the ball *h* touches the under surface of the knife near its edge, throughout its length; and when this has been accurately effected, the division of the scale K, which the pointer P indicates, is noted.

A definite position or line is thereby obtained, so that the knife can be raised or lowered without deviating from its correct position, and, in other words, it may be said that the purpose of the foregoing apparatus is to enable the microtomist to put the section line of the knife in a plane parallel to the course of the slide, and also to render it possible to lower the edge and raise the back without the plane which the knife-edge

describes ceasing to be parallel to the course of the slide. We cannot pretend, however, to have very clearly understood the author's views.

Sectioning fresh Cartilage by partial Imbedding.*—Mr. B. L. Oviatt first removes the end of the bone by cutting through it at 2 or 3 centimetres from the joint. The well of the microtome is then filled with paraffin to within about one centimetre of the top, and as soon as it begins to turn white from cooling the bone is inserted until the cartilage is in the plane of the microtome or a little below it. While the paraffin is cooling the cartilage is prevented from drying by placing on it a little cotton wool wet with artificial serum or salt solution. By this method sections may be obtained of uniform thickness, and more rapidly than by the old method. It is also applicable for sectioning injected tissue if care be taken to cut very slowly and with a drawing motion, and at the same time to keep the tissue and knife wet with 25 per cent. spirit.

Cutting Sections of delicate Vegetable Structures.†—Mr. W. A. Haswell considers there is a difficulty in obtaining by the means ordinarily recommended, with considerable pains and loss of time, a number of fine sections of such delicate vegetable structures as the prothallium of a fern, fronds of delicate seaweeds, or thin and flexible leaves of land plants; and that the following method, which he has found of service, will recommend itself by its simplicity.

The specimens to be cut, if they have been in alcohol, are placed in water for a few hours, and then for a day in a thick solution of gum arabic; if fresh they may be placed at once in the gum. Small pieces of carrot are placed in the gum for the same length of time. The specimens to be cut and the carrot which is to form the imbedding material are now thoroughly saturated with strong gum solution. Slits are made in the pieces of carrot, and the thin structures to be cut are inserted in the slits, any interstices being filled up with gum. The blocks of carrot, with the imbedded specimens, are then frozen and cut in the usual manner with the freezing microtome. When the sections are placed in water there is little difficulty in picking out the sections of the imbedded objects from the light-coloured and flocculent sections of the carrot—an operation which is facilitated by agitation of the water, when most of the narrow needle-like sections of the thin objects will find their way to the bottom of the vessel.

Kühne, H.—**Dr. R. Long's neues Mikrotom.** (Dr. R. Long's new microtome.) *Breslauer ärztl. Zeitschr.*, 1886, pp. 284–5.

[Osborn, H. L.]—**On treating Chicks for Section-cutting.** *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 29–31.

Queen & Co.'s (J. W.) New Model Microtome. [*Post.*] *The Microscope*, VII. (1887) p. 17 (1 fig.).

Reeves, J. E.—**Cutting Sections of Animal Tissues.** *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 12, 14–5, *St. Louis Med. and Surg. Journ.*, li. (1886) pp. 340–4, lii. pp. 159–60.

Smith, J. L.—**[Making Sections of Embryo Chicks.]** *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 37–8.

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* St. Louis Med. and Surg. Journ., li. (1886) pp. 208–9.
† Proc. Linn. Soc. N. S. Wales, l. (1886) p. 489.

(4) Staining and Injecting.

Staining the Retina by Weigert's Method.*—Dr. R. Lennox hardens the retina of man and of the cat in Müller's fluid and alcohol, and imbeds in celloidin. The sections are placed for about twenty-four hours in a 1/2 to 1 per cent. chromic acid solution, and then, after having been washed in water, in Weigert's hæmatoxylin (1 part hæmatox., 10 parts alcohol, 90 parts water). If kept at a temperature of 40° C. they remained in the logwood solution for two hours; if at ordinary temperature, a longer time. The sections were then decolorized by the cyanide solution (ferrocyanide of potash 2·5, borax 2, water 100). When they became yellowish (about half an hour) they were washed, dehydrated, and mounted in balsam. Nerve-fibres (cat) came out as dark varicose threads. Two kinds of ganglion cells were distinguished:—(1) large yellowish elements with bright nuclei and black nucleoli; (2) dark cells with perfectly black nuclei. In the internal granular and epithelial layers (man) this difference of the nuclei also occurs. The nuclei of the cones are usually black, those of the rods bright with black nucleoli. Of these differences the author offers no explanation.

Staining Tubercle Bacillus.†—Herr Gottstein attacks Ehrlich's explanation of the Ehrlich staining process, i. e. the investment theory which supposes a qualitative difference, while Gottstein and others only accept the presence of a quantitative difference. The author calls attention to the fact that a property of certain constituents of the formula used for staining renders it possible to dissolve twice as much of the dye as distilled water would take up. Consequently the solution acts from concentration and not by any specific virtue. Then as regards resistance to mineral acids, treatment with decolorizing agents shows that the more lightly a dye is bound up to the tissue the more easily is it disassociated therefrom, a confirmation of Gierke's dictum that staining in general is not a chemical but a physical process, and depends on diffusion and imbibition. The resistance of the tubercle bacillus to decolorizing agents is to be explained, according to the author, by supposing that it has a quantitatively slight disposition for imbibition of solutions.

Phenomenon in Anilin Staining.‡—Mr. E. H. Wagstaff in the summer of 1884 mounted several slides of desmids, *Spirogyra*, and other algæ, the mounting substance being the article commonly known as "French polish," coloured with the addition of a little anilin-green and well mixed together. The slides were spun in the usual manner on the turntable, the cells being finally finished off with a last touching-up with the "French polish." About six months after he found the specimens had become stained a beautiful and vivid green, of course rather too vivid, but nevertheless quite a surprise. The specimens stained were *Spirogyra inflata*, *S. Weberii*, *S. quinina*, *Stauraspermum gracile*, and *S. viride*. The desmids so treated were *Closterium rostratum* in conjugation, and *C. Leiblorii*, &c.

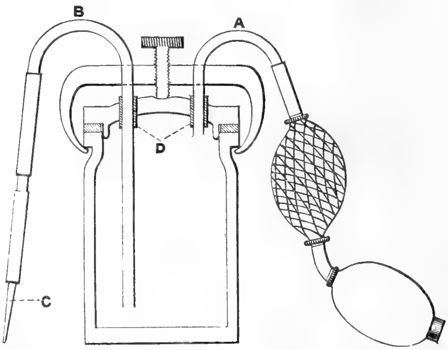
Congo Red.§—Dr. F. Nissl gives the following (provisionally) as a staining method for axis cylinders:—Chromate of potash; alcohol, 95 per cent.; watery solution of Congo red, 5 to 400; alcohol, 95 per cent., three

* Arch. f. Ophthalm., xxxii. (1886) 8 pp. and 1 pl.
† Deutsche Med. Wochenschr., 1886, No. 42.
‡ Sci.-Gossip, 1887, p. 41.
§ Münchener Med. Wochenschr., 1886, p. 528.

to ten minutes; nitric-acid-alcohol ($3HNO^3$ to 100 C^2H^6O), about six hours; alcohol, one to five minutes; oil of cloves or origanum; balsam.

Gage's Injecting Jar.*—Prof. S. H. Gage's injecting jar (fig. 91) grew out of the necessity for some simple and efficient apparatus for injecting liquids (chloride of gold, nitrate of silver, nitric, chromic, osmic, and picric acids) which would be injured by or injure an ordinary syringe. As will be seen, it is made on the principle of an ordinary wash-bottle. It is prepared by boring two holes in the glass cover of a fruit-jar or of an anatomical specimen jar, and inserting glass tubes, the pressure-tube A just penetrating the cover and the delivery-tube B extending nearly to the bottom of the jar. Where the glass tubes penetrate the cover they are surrounded by rubber tubing D, to render the joints air-tight. The pressure is obtained by the use of an atomizer bulb, or, in order that it may be constant, two bulbs are used, the second one being covered with a net to prevent undue distention. The delivery-tube and the cannula C are of glass, only enough rubber tubing being used to make the delivery-tube outside the jar flexible.

Fig. 91.



While this jar was designed for special liquids, it has been found excellent for making fine injections with gelatin mass. With two bulbs, as in the figure, a pressure of 40 mm. of mercury may be obtained; this is sufficient for most purposes. While water or mercury might be used to obtain the pressure, as in the various forms of constant pressure apparatus, the atomizer bulbs are preferred, as it is easier for the operator to control the pressure and adapt it to the individual cases.

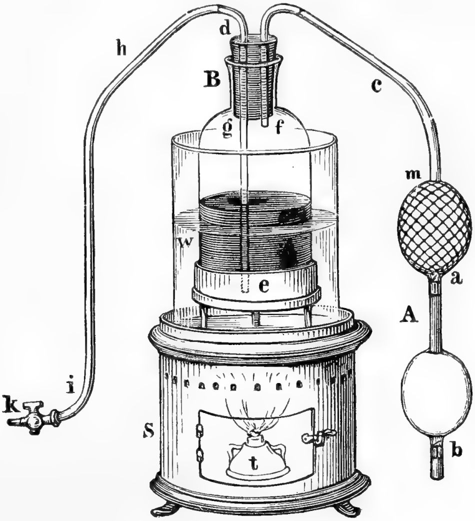
Stein's Injection Apparatus.†—The injection apparatus used by Dr. S. T. Stein is shown in fig. 92. In this instrument the required force is derived from the action of compressed air upon a column of liquid, and it consists accordingly of two parts—A the compression-pump, and B the vessel which holds the liquid. The pump A, made of guttapercha, consists of an air-bag *m* into which air is forced by means of a collapsible ball and the two valves *a* and *b*. From *m* the air passes by the tube *c f* into B through the rubber-stopper *d*, which admits by air-tight openings that and another tube *g h*. The end *f* of the first tube does not penetrate far into the vessel, but the second tube *h g* extends into the injection-fluid, while its other end *i* is closed by the stop-cock *k*. When the stop-cock is open the apparatus yields a continuous stream from $2\frac{1}{2}$–3 metres in height, which by closing *k* may be reduced to a slow succession of drops. B stands upon the support *e*, and is immersed in a water-bath *w*, which is heated by the spirit-lamp *t* in the chamber *s*.

For this apparatus the author claims the advantages that it is completely under the control of the operator, whose hands are moreover left free; it may be used for all sorts of cold and warm injections, including chemical

* The Microscope, vi. (1886) pp. 265–6 (1 fig.).
† Stein, S. T., 'Das Licht,' 8vo, Halle, 1884, pp. 307–10 (1 fig.).

solutions such as nitrate of silver, and none of the liquid is lost, while the whole apparatus is easily cleaned by pumping a stream of warm water through it.

FIG. 92.



Nitrite of Amyl for Fine Injections.*—Messrs. B. L. Oviatt and E. H. Sargent suggest the employment of amyl nitrite for fine injections, and point out three methods for its exhibition. 1. A mixture of ether and amyl nitrite may be poured into the box in which the animal is killed, and when quite anæsthetized a sponge moistened with pure nitrite may be held over the animal's nose until it is quite dead. This procedure is not recommended. 2. After being anæsthetized with ether, the nitrite may be held over the nose, or the animal may be removed from the box, and after the sponge is applied the head wrapped up in a rubber sheet. 3. Injection of a small amount of nitrite in salt solution into the vessels directly after death by either of the foregoing methods. In any case it is advisable to add a little nitrite to the mass just before using. The relaxing power is so great, that the largest arteries will be found collapsed.

DEKHUYZEN, M. C.—**De aard van het proces der Kleuring van mikroskopische praeparaten.** (The nature of the process of staining microscopical preparations.)
Nederl. Tijdschr. v. Geneesk., 1886, pp. 585–8.

GRAY, N. M.—**A Modification of Weigert's Method of staining Tissues of the Central Nervous System.** [*Post.*] *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 31–2, from *Med. News*, 1886, Nov. 6.

GRIGORJEW, A.—[**On Ehrlich's Staining of Micro-organisms.**]
[In Russian.] *Russkaja Medecina*, 1886, No. 42.

HANKIN, E. H.—**Some new Methods of using the Aniline Dyes for staining Bacteria.**
[*Post.*] *Quart. Journ. Micr. Sci.*, XXVII. (1887) pp. 401–11.

KÜHNE, H.—**Zur Färbetechnik.** (On staining technique.)
Zeitschr. f. Hygeine, I. (1887) pp. 553–6.

S., R. J.—**Staining Fluid.**
[Carmine, 10 grns.; strong liquid ammonia, 1/2 drachm; Price's glycerin, 2 oz.; distilled water, 2 oz.; alcohol, 1/2 oz.].
Scientif. Enquirer, II. (1887) p. 30.

* St. Louis Med. and Surg. Journ., li. (1886) pp. 207–8.

(5) Mounting, including Slides, Preservative Fluids, &c.

Thymol in Microscopical Technique.*—Dr. G. Martinotti concludes from his own experiments and the researches of others that although thymol may have a useful application in microscopy as an antiseptic, it should not be employed when the tissues to be examined have been or are to come in contact with chromic acid or its salts.

If to a watery solution of chromic acid a watery solution of thymic acid be added, a precipitate forms, even when not exposed to light, and this precipitate is devoid of the characteristic smell of thymol. After washing the precipitate, the filtrate is found to be a yellow odourless powder, which examined microscopically consists of amorphous granules and a few small prismatic crystals. This precipitate is insoluble in water, insoluble or nearly so in alcohol, ether, chloroform, benzine, in water acidulated with sulphuric, hydrochloric, nitric, acetic, formic, and oxalic acids, in ammonia, in anilin diluted with alcohol. If an alcoholic solution of thymol be added to the watery solution of chromic acid the action is so energetic that the temperature rises from 70° to 80° C. The precipitate is produced as before, but the mass assumes a blackish colour, as if mixed with some carbonaceous matter.

Again, if thymol crystals be thrown into the chromic acid solution they become invested by a precipitate, while their central parts retain their usual character. With solution of potassium bichromate similar results follow, but more slowly.

Hence a chemical action takes place between thymol and chromic acid, and this action is a process of oxidation. So the writer assumes from the researches of Lallemand, Carstanien, and others who have examined the relations and composition of thymol.

As remarked above, the conclusion arrived at is that thymol is unsuitable as a microscopical reagent in conjunction with chromic acid or its salts. With other reagents, such as picric acid, carmine, gum, and gelatin, thymol works well.

Hilgendorf's Apparatus for Dehydrating Microscopical Preparations.†—Herr F. Hilgendorf's apparatus consists of a test-tube (for small objects, about 50 mm. long and 6 mm. broad) into which is filed, about 5–10 mm. above the bottom, a small hole. The aperture may, if necessary, be lessened by means of a wood-splinter. The object is then placed in this tube, *partially* filled with weak spirit, and the upper end closed with a cork. Thus prepared, the tube is inserted into a closed vessel filled with absolute alcohol. Through the small hole the latter finds its way into the tube, and continues to do so for a half to one hour. At a height of 1 cm. diosmosis was found to require several days, but the rapidity of the action can be proportionately increased by filing the hole lower down. Several tubes, and this is a great advantage, can be placed in the outer vessel at the same time. It is recommended to use some hygroscopic substance, as burnt copper sulphate, &c., to keep the dehydrating fluid as concentrated as possible.

Method for treating Serial Sections imbedded in paraffin by Weigert's method.‡—Weigert's method of making serial sections of celloidin preparations was described in this Journal, 1886, p. 349.

Prof. H. Strasser describes the following improved method, in which

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 351–8.
† SB. Gesell. Naturf. Freunde zu Berlin, 1886, pp. 133-5.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 346–50.

the stiff glass plates are replaced by a pliant medium that allows fluids to penetrate from both sides, the paraffin-imbedded sections being attached to gummed paper by means of collodion.

The gum-collodion plates are made by covering one side of a smooth piece of writing-paper, duodecimo size, with a thick layer of gum arabic. As soon as the gum ceases to be sticky, the paper is flattened out smooth in a hand-press, care being taken that there are no unevennesses. Thick-flowing collodion is now passed over the gummy side, and a smooth layer having been obtained, the plate is again pressed out between two firm, smooth surfaces in the hand-press. Upon the plate thus obtained the sections are then fixed by means of a mixture of 2 parts collodion and 1 part oil of cloves. For large and thin sections it is necessary to use a section-stretcher of special construction. This, however, remains to be described. Over the whole a thin layer of the collodion clove-oil mixture is then brushed with a camel's-hair pencil.

The paraffin is next dissolved out by laying the plate in a dishful of benzin for 15–30 minutes. The plate is then dried with blotting-paper, and at once transferred for a few minutes to 95 per cent. alcohol. It is then dried again, and to keep up a perfectly smooth surface the sections must be brushed over, if need be, with the collodion clove-oil mixture. It is next transferred to 80 per cent. alcohol, wherein it remains for a quarter of an hour or more. When sufficiently hard, these plates may be treated in any watery or water-and-spirit solution. The watery solutions of course set free the collodion plate by dissolving the gum. Clearing up and mounting are performed in the usual way with creosote and Canada balsam.

Permanent Caustic Potash Preparations.*—It is usually stated that specimens treated with caustic potash cannot be permanently preserved. During the past summer an aqueous solution of caustic potash of 35 to 40 per cent. was used by Prof. S. H. Gage for isolating cardiac muscle from many different animals; as some of the preparations were drawn it seemed unfortunate not to be able to render them permanent as vouchers for the drawings. This was accomplished by adding glacial acetic acid to the isolated cells. The acid combines with the caustic potash to form acetate of potash, which is often used for permanent mounting; finally a mixture of glycerin 75 parts and an aqueous solution of picrocarmine (1 per cent.) 25 parts was added as a permanent mounting medium. These specimens after three months show no signs of deterioration. If the specimens were already under the cover-glass, a drop of glacial acetic acid was drawn under it and afterwards a drop of the glycerin and picrocarmine mixture.

How Alcohol drives out Air-bubbles.†—M. L. Errera remarks that that which renders air-bubbles so persistent in organic tissues is, in the first place, their extreme minuteness; then the thin layer of water which encompasses them holds in solution a certain quantity of organic matter; whence arise an increase of the superficial viscosity, and a diminution of the tension, both favourable to persistence.

But the air-bubbles should disappear if for water be substituted a liquid endowed with the three following properties:—(1) It must be perfectly miscible with water. (2) Its superficial tension must be weak. (3) Its superficial viscosity must be weak. Now, of all the liquids indicated by Plateau, who has made some very original observations on the superficial and internal viscosity and tension of fluids, only two fulfil both conditions. These are ether and alcohol, both of which ought to rapidly drive out air-

* The Microscope, vi. (1886) p. 267.
† Bull. Soc. Belg. Micr., xiii. (1886) pp. 69–75.

bubbles from microscopical preparations. As the superficial viscosity of ether is very feeble, and its tension less than that of alcohol, it should be preferable for the purpose to the latter, though it must be borne in mind that ether is not miscible with water, like alcohol, in all proportions. But, as a matter of fact, experience shows that ether does cause to disappear, just as alcohol does, the air-bubbles adhering to organic tissues.

Krönig's Cement.*—Dr. Krönig calls attention to the convenience of a sealing cement composed of two parts of wax and seven to nine parts of colophonium. The colophonium is added piecemeal to the melted wax, the result is filtered, and the mass left to cool. Solid at ordinary temperatures, it is readily melted by placing the containing vessel in hot water. As it hardens rapidly, the preparation can be finished at once. It is insoluble in water, glycerin, and caustic potash; its consistence is good; its composition is cheap and simple.

Aylward's (H. P.) Opaque Wood Slide.

["Parallel-sided, sunk cell, beyond which is a parallel-sided groove to hold a brass-flanged ring. The object is put into the cell, a thin cover-glass laid on the top of it, and the brass ring dropped into position holds all perfectly secure, and if pressed tightly down, we believe, air-tight also. The special qualifications Mr. Aylward claims for this slide are its simplicity, and also that owing to the dryness of the wood botanical objects need not be thoroughly dried before mounting. The wood will absorb all dampness that may be left, and in so gradual a manner that all shrinking or curling of the specimen will be avoided."]

Scientif. Enquirer, II. (1887) p. 39.

GAGE, S. H.—**Centering Card.**

[The card is prepared by making upon it several concentric circles, and then cementing to it pieces of glass or Bristol board, so that when the slide is placed in position the centre will be over the centre of the circles.]

The Microscope, VI. (1886) pp. 266–7 (1 fig.).

GUARDIA, J.—**Hints for Microscopists.**

[To view preparations from both sides with high powers:—Two thin strips of wood, brass, cardboard, &c., 3 in. × $1\frac{1}{2}$ in. From the centre of one cut out a square 3/4 in. side, and from the other a square slightly larger than 7/8 in. side. Glue the two strips together, and there is a ledge 1/16 in. for the preparations to rest on. The specimens are mounted between two 7/8 in. cover-glasses and put in the frame or carrier.]

Engl. Mech., XLV. (1887) p. 11.

HEURCK, H. VAN.—**Nouvelle préparation du Médium à haut indice (2·4) et note sur le liquidambar.** (New preparation of the medium of high index (2·4), and note on liquidambar. [*Post.*] *Bull. Soc. Belg. Micr.*, XIII. (1886) pp. 20–4.

MORRIS, W.—**Notes on experiments in mounting the Amphipleura pellucida in media having a higher refractive index than Canada balsam.** [*Post.*]

Journ. and Proc. R. Soc. N. S. Wales, XIX. (1886) pp. 121–33.

VRIES, H. DE.—**Over het bewaren van plantendeelen in spiritus.** (On the preservation of parts of plants in spirit.) [*Post.*] *Maanbl. v. Natuurwet.*, 1886, No. 5.

(6) Miscellaneous.

Two new Sugar Reactions.†—Dr. H. Molisch found that sugar solutions, with the exception of inosite, immediately assume a deep violet colour on the addition of some drops of a 15–20 per cent. α naphthol solution and sulphuric acid in excess, and that the addition of water then produced a deep violet precipitate. If thymol be added to the α naphthol the colour becomes a bright ruby red, and the precipitate, from water, is carmine red. In this way 0·00001 per cent. of sugar can be demonstrated. Carbohydrates and glucosides also give these reactions, but more slowly, and after the action of sulphuric acid.

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 657–8.
† SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 912–23.

From the foregoing considerations Molisch bases the following method for demonstrating sugar in plant sections:—A not too thin section laid on a slide is treated with a drop of 15–20 per cent. alcoholic α naphthol solution, then two or three drops of concentrated H_2SO_4 are added. If the section contains sugar the violet coloration appears in less than two minutes. In other carbohydrates the colour appears in a quarter to half an hour. In practice two sections are used; one of these is boiled for a few minutes in water, whereby sugar, dextrin, gum, and glucosides are dissolved. The two sections are then submitted to the same test, and if sugar is present in the unboiled section the coloration immediately appears. As dextrin, gum, and glucosides may be usually disregarded, the appearance of the violet, &c., staining indicates with great probability the presence of sugar.

The foregoing test may be used to demonstrate the presence of inulin, which by Sachs's method is liable to be confounded with sphæro-crystals, for these become immediately stained deep violet with α naphthol and sulphuric acid, and on the addition of thymol are dissolved with the production of a red colour.

These reactions may be used for the detection of sugar in urine. Without any preparation normal human urine exhibits them distinctly, even when it is diluted from 100 to 300 times; and the presence of grape-sugar is therefore absolutely determined in the urine of man in a normal condition. A simple method, based on these reactions, is given for the distinction of diabetic from normal urine.

Discrimination of Butter and Fats.—Prof. H. A. Weber * has made further experiments upon the microscopic methods of distinguishing butter from other fats proposed by Dr. T. Taylor. †

Dr. Taylor's first claim was that butter, cooled slowly under certain conditions, formed "globules," which, when viewed by polarized light, showed a well-defined St. Andrew's cross. Prof. Weber having shown that this appearance was not characteristic of genuine butter, but might be produced in any common fat by treatment similar to that applied to the butter, Dr. Taylor then called attention to another test as being characteristic. According to this, if a sample of butter is viewed by polarized light, a plain selenite being placed between polarizer and analyser, a uniform colour is observed; if any solid fat, like lard or tallow, be thus viewed, the fat will exhibit prismatic colours. Prof. Weber finds this test as fallacious as the former. Any of the fats under consideration, if melted, and cooled slowly, and then submitted to Dr. Taylor's test, will show the prismatic colours, due to the action of the comparatively large crystals formed upon the polarized light. On the other hand, the same fats, if cooled quickly, so as to prevent the formation of large crystals, present the uniform tint claimed by Dr. Taylor as characteristic of butter fat.

Dr. Taylor in reply contends ‡ that Prof. Weber's experiments were erroneously carried out, and his views are defended against those of Prof. Weber by Mr. R. Hitchcock. § Mr. C. M. Vorce also corroborates ‖ Dr. Taylor, and describes a modified method of his own.

Dr. J. H. Long, ¶ on the other hand, considers that we have no abso-

* Science, vii. (1886) p. 524, from Bulletin No. 15 Ohio Agricultural Experiment-Station.

† See this Journal, 1885, pp. 356 and 918. It would seem from the above that these two extracts, though given in the order of date of the sources from which they were taken, were chronologically reversed. See also this Journal, 1886, p. 174.

‡ The Microscope, vi. (1885) pp. 78–9, and see pp. 85–6. Amer. Mon. Micr. Journ., vii. (1886) pp. 169–70.

§ Amer. Mon. Micr. Journ., vii. (1886) pp. 119, 135–7. ‖ Ibid., pp. 156–7.

¶ Bull. Illinois State Micr. Soc., May 14, 1886, 5 pp. and 1 pl.

lutely certain method of distinguishing between butter and some of its substitutes, and that of all methods proposed, the microscopic are perhaps the least reliable.

Microscopic Structure of an Armour-plate.* — Dr. H. Wedding describes the microscopical examination of a compound armour-plate, from which it appears that the different varieties of iron and steel used in the construction of such a plate can be recognized without difficulty by means of the Microscope. The plate examined, which was one of the largest used (300 mm. thick) consisted of a base composed of a series of hammered plates of puddled iron 35 mm. in thickness, welded together into a plate of 215 mm. thickness; a face of cast iron (containing 0·45 per cent. of carbon) rolled into a plate 15 mm. thick; and an intermediate layer of steel which had been run in between these two plates and allowed to solidify; the whole being finally rolled at a red heat.

A transverse section was polished, cleaned with water, alcohol, and ether, etched with a weak solution of hydrochloric acid (one drop of acid in a litre of water), cleaned a second time, and then tempered to a yellow tint, when the etched figures stood out in orange upon a yellow ground.

The section was then submitted to microscopical examination and the following features were observed. The surface-plate displays the characteristics of cast iron poor in carbon, namely homogeneous iron with uniform inclusions of angular flakes and crystals of iron; in the steel plate the homogeneous iron is reduced to a network enclosing large masses of crystallized iron and small pores; while the base-plate is characterized by welding joints in the form of pores permeating stringy iron in which the crystalline structure is developed parallel with the joints. The quantity of crystals present may be regarded as an indication of the percentage of carbon, and they are seen to diminish in number where the otherwise homogeneous iron of the surface-plate comes into contact with the steel. Other changes of character observed near the point of contact of the different materials are detailed by the author and suggest that the Microscope may perhaps be used not only to determine the nature of the metal, but also to estimate its homogeneity, purity, &c.

Microscopist's Working Table.†—In a series of articles on "The Naturalist's Laboratory" by an anonymous writer, a microscopist's working table is thus described:—"As a very large part of the naturalist's work nowadays calls into use that most useful of modern inventions, the compound Microscope, a special table designed to facilitate research must here be looked upon as something indispensable. The objects of the design, now submitted to the notice of students of nature for the first time, are to afford general convenience during study, and to enable one to record observations graphically on the spot. To accomplish these the table is divided into two parts, the microscopist's, M (figs. 93 and 94), and the artist's portion, D. The dimensions of the table are clearly indicated on the figures. Fig. 93 is a working plan to show the end elevation of the structure; fig. 94 gives a good idea of the shape of the table-top. Each part is furnished with two drawers as shown in fig. 93; the drawers under D afford space for the storage of colour-boxes, pencils, paper, &c.; those beneath M are intended to receive microscopical accessories, such as glass slips, instruments, live-boxes, troughs, and the hundred and one odds and ends that may be required from time to time by the worker in Nature's unseen universe.

* Verh. Ver. zur Bef. d. Gewerbfleisses, 1886, p. 293. Cf. Naturforscher, xx. (1887) pp. 18–9.

† Knowledge, x. (1887) pp. 80–1 (2 figs.).

"The longest end of the table ought to face a window approximately looking northwards. The worker seated on the bench T can thus employ direct or reflected light according to the position, inclined, upright or horizontal, in which he places his Microscope. To his right there is fixed a reagent stand, R. As soon as he has completed his observation, or adjusted an object which he deems worthy of delineation, he should shift his instrument to the position D and take his seat upon the chair S. By so doing, he will gain the inestimable advantage of working in a clear

FIG. 93

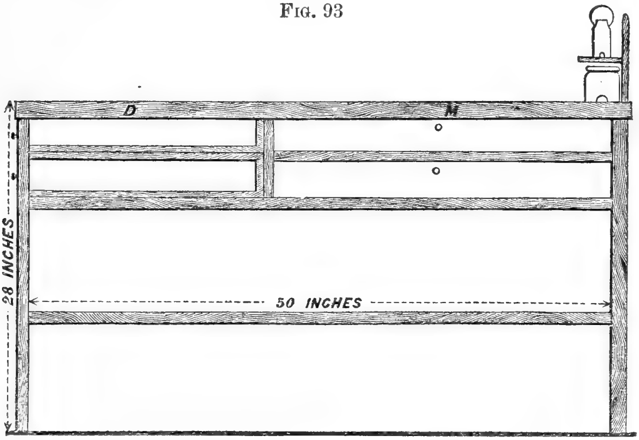
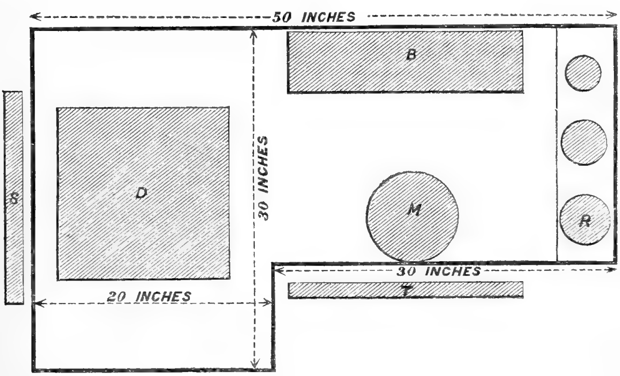


FIG. 94.



transmitted light without the chance of a vitiated result through interference rays, and with absolute security against the evil effects of a more or less intense glare. The value of thus being able to shift one's position from front to side on the table will soon become evident to workers with the Microscope who indulge in prolonged observations. The top plan (fig. 94) shows the position of the Microscope during investigation, or whilst mounting objects; B, place for a dust-proof box, for use whilst preparing specimens for observation, a detailed description of which will be given in the sequel;

D, the position of the Microscope when used with the camera lucida for delineating objects, or when employed with the polariscope, or where pure transmitted light is alone admissible; R, the reagent-stand."

Ward's Catalogue of Microscopical Collections.—Dr. R. H. Ward has prepared a convenient form of catalogue for recording a large number of brief data of objects. Each double page has space for 10 objects and the data are grouped in four columns. Below is a specimen of the heading of a page and one of the 10 spaces; the columns for preparation and mounting are not, however, beneath the other two but run across the right-hand page. Each book contains space for 1000 or 2000 objects as preferred. There is an appendix for long notes, special methods, formulæ, &c., and an alphabetical index.

(*Left-hand Page.*)

Slide No.	NAME.	SOURCE.
	c. Common Name. **s.** Scientific Name. **N.** Special points shown, Illumination or Powers required, Reference to authorities, &c.	**h.** Habitat or Locality. **c.** Collector (Presented, Purchased, Exchanged, &c.)
1	c	h
	s	c
	N	

(*Right-hand Page.*)

PREPARATION.	MOUNTING.		
p. Preserved (Hardened, Macerated, Decalcified, Injected, &c.). **ct.** Cut (Imbedded, Frozen, Microtome), Teased, &c. **st.** Stained. **cl.** Cleared.	**m.** Mounting Medium. **cc.** Cell and Cement. **cg.** Cover-glass Thickness. **r.** Repairs or Disposal (Broken: Cement run in: Air in: Given to or Exchanged with, &c.).	**d.** Date.	**lc.** Location in Cabinet.
p	m		
ct	cc		
st	cg	d . .	lc
cl	r		

Dr. Dallinger's Address.—The following * is a popular appreciation of Dr. Dallinger's last address.

"It is difficult to say whether the wonders that reward the patient servants of science are more attractive in the direction of the infinitely little or of the infinitely great. In both of these fields there are faithful workers, constantly striving to enlarge for us the bounds of human knowledge, albeit

* Daily Telegraph, 19th Feb., 1887, p. 5.

mankind is not grateful enough for their toil. Experimental researches, like those which Mr. Crookes explained last night at the Royal Institution, force the mind to consider matter in its ultimate and minutest forms as analysed by the electric spark and the spectroscope, in atmospheres millionths of our common air in tenuity; and they are not less wonderful than the contemplation of worlds thousands upon thousands of times larger than our own. Our astronomers are engaged at present in photographing the face of the midnight heavens, having discovered that the film which they expose to the sky is far more sensitive to light than the keenest human eye, and more than one observatory is thus registering distant and minute stars previously unknown. The stellar universe has been by such means perceived to be more crowded with life and glory than had been realized; and night after night the astronomer's camera in this silent way prints off accurate pictures of seen and unseen immeasurably distant worlds. Meanwhile, coming from the realms of matter to the sphere of life, the microscopists are quite as busy as the telescopists, and the results which they achieve, although drawn from regions that escape us by minuteness, often shed new rays of truth over those problems of living nature which baffle us by their vastness. The Rev. Dr. Dallinger, President of the Royal Microscopical Society, delivered an address last week which well illustrates this view, while it gives an example of the admirable and unceasing devotion shown by our best scientific men. After dwelling on certain recent improvements in the construction of lenses, the President, on the occasion referred to, proceeded to describe a series of experiments which he has conducted for nearly ten patient and faithful years. Long ago Darwin expressed the opinion that if we would actually observe and demonstrate the manner in which living creatures adapt themselves, by inward and outward modifications, to changed circumstances, and so produce what are called new species, it must be by watching the lowest and least visible organisms. To such a task Dr. Dallinger set himself. His project was to place and keep under his lens several varieties of those minute monads which are incessantly multiplying by fissure or division, and which are nearly at the bottom of animated nature. The generations of these creatures succeed each other about every four minutes; so that, in the course of an hour, we can view the passage of fourteen or fifteen generations, which would answer to something like four hundred and fifty years of human history, while a day of monadic existence would represent more than ten thousand of our years. These monads live in water, and by connecting the drop that serves them for a habitable and roomy ocean with the ingenious apparatus of Prof. Schäfer the temperature of this drop can be either kept constant or raised very slowly and with absolutely steady precision. Here, therefore, were the conditions requisite for gradually altering the climate in which these monads throve; and if it could be proved that such tiny infusoria could indeed be slowly accustomed to changes greater than would be suffered by animals removed from the Equator to the Pole, then bright and trustworthy light would be cast on the modifications of life which we see arrived at on the earth, and Darwin's great law would be largely removed from theory to recorded fact. To carry out so very delicate an investigation, however, it wonld have to be prolonged for months and even years, in order to imitate the immense deliberation with which Nature herself accomplishes every substantial change in her highest productions. Night and day, winter and summer, the patient gaze must be kept fixed on those merest specks of silvery life which had to be nursed into new conditions of existence. The slightest accident to the apparatus might in one moment render the whole experiment void, and leave the drop of water as lifeless as these islands

would be if another glacial period suddenly arrived. The only reward, on the other hand, for successful and almost inconceivable perseverance would be the discovery of truth, and the reinforcement of Darwin's sublime generalisation. But, for the sake of these, which always satisfy the noble ardour of science, Dr. Dallinger has given as many years of his life as were spent by the Greeks in the siege of Troy, and has apparently won a scientific victory, the value of which is as signal as his ingenuity and devotion are admirable.

We will endeavour very briefly to describe the method and the outcome of his most remarkable experiments. The group of microscopic monads were put under the lens in a well-fitted water-cell at their usual temperature of 60° F., the apartment, the apparatus, and all round being carefully kept in precise unison. The Doctor then spent the first four months of his observation in raising the temperature time after time by stages less than one-sixth of a degree, until his swarm of protozoa had reached the new and advanced reading of 70° F. This change, nevertheless, had no more disturbed them than that experienced by a British family when it migrates from London to Cape Town; the life-history of each group remained unaltered; they moved, gyrated, fed, and split themselves into new individuals in just the same manner and within much the same period as before. When, however, three more degrees had been added to the seventy, the monads showed signs of being decidedly inconvenienced. They were neither as lively nor as productive as formerly; yet, by keeping them exactly at this range during two quiet months they regained their full vigour, and might be compared to emigrants who had become seasoned by surviving the first hot spell in a tropical country. They could now stand—by gradual steps of increase—the enhanced heat of 78°, which was reached at the commencement of the twelfth month. Yet here, again, a long pause was found to be necessary; the new generations of those silver specks of life under the glass were not all alike strong enough to live and thrive. What answers to sunstrokes and fevers with us had caused vacant spaces to appear in the water-drop, and it was only when the monads showed themselves once more lively and prolific by a long era of repose that the careful Doctor administered a further dose of caloric. During eight years and a half did he thus slowly and unweariedly proceed in the same course, augmenting the heat of their surrounding element now and then by slow and slight additions, pausing afterwards for months to give the minute creatures time to accommodate themselves when signs were visible that they were under difficulties, and always going forward to new trials of endurance when they had recovered. In this manner, after all those many years, Dr. Dallinger brought his small patients to the astonishing range of 158° F., at which the latest generation appeared 'as jolly as sand-boys.' It is not possible to say how much farther their tiny constitution could have been trained to defy increasing warmth, because the research was at this point accidentally terminated; but it will be seen that the Doctor had brought the little people of his drop-world to sustain a heat nearly one hundred degrees higher than the flourishing point of their ancestors, any species of which, if taken at the beginning, would have been completely and instantaneously killed in water of one hundred and forty degrees. When we have added that these minute salamanders perished directly they were put back into their ancestral medium of sixty-five degrees, if will be manifest that the indefatigable Doctor had, by the magic of science, effected a miracle of Nature almost as striking as if the *Protococcus nivalis*, which stains the Arctic snow with crimson, had been transformed into the great grasses and feathery bamboos which clothe the burning sides of a mountain under the Equator.

The biological importance of these observations will furthermore be evident to all intelligent minds. There must have passed under the eyes of Dr. Dallinger, during his watch, something like half a million generations of the minute organisms. His augmentation of temperatnre had meanwhile represented the sudden changes which may have come upon earth-life, while his pauses answered to those periods of steadfast conditions which must have intervened, and given to living things leisure to accommodate their organs to new circumstances. Thus the ages of our planet's history were condensed, so to speak, under the vigilant eye-piece of the Doctor's Microscope, and these seven or eight years of observation furnished an epitome of the earth's entire existence. They proved to demonstration in these low forms what we can only guess at with regard to the higher plants and animals. Darwin constantly insisted upon the slowness of the process of adaptation, and, if we should seek to transpose the advances and the pauses of these seven or eight years into terms proportionate for higher orders of life, the figures would become truly prodigious. Yet no change from sea to land, or from icebergs to tropical forests, could be relatively greater than that triumphantly borne by these infusoria. And, if it be objected that they are of an organism too degraded and too primitive to bear any practical relation to the highest grades of life, the answer is obvious and convincing. Those higher species, whether plants or animals, are mainly built up of vast aggregations of cells; and these cells, though differently endowed in different parts of the frame, are very like the monads in many respects. Thus the patient experiment has, in truth, a clear and most valuable bearing upon the problem of gradual evolution in all its stages and illustrations, and light is cast upon the grandest operations of Nature by the way in which these tiny mere dots of protoplasm 'live and move and have their being.' Nor could better proof be wanted of the way in which the infinitely little illuminates, as we have said, and explains the infinitely great."

Boudier, E.—**Considérations générales et pratiques sur l'étude microscopique des Champignons.** (General and practical considerations on the microscopic study of fungi.) *Rev. Mycol.*, VIII. (1886) pp. 215–8.

Cole, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. No. 7 (each 4 pp.).

Sec. I. Botanical Histology. No. 7. Studies in Vegetable Physiology. VII. Haustoria. (Plate VII. Dodder in parasitic connection with clover.)

Sec. II. Animal Histology. No. 7. The Ovary and Ova in Birds. (Plate VII. Ovary of Bird × 50.)

Sec. III. Pathological Histology. No. 7. Fatty Degeneration of Kidney (Phosphorus poisoning). Waxy disease. (Plate VII. Fibrosis of Kidney.)

Sec. IV. Popular Microscopical Studies. No. 7. Microbes. (Plate VII. Microbes.)

Jennings, C. G.—**The Microscopic Examination of Urinary Deposits.** *The Microscope*, VII. (1887) pp. 9–10.

Kastschenko, N.—**Methode zur genauen Reconstruction kleinerer makroskopischer Gegenstände.** (Method for the exact reconstruction of small macroscopic objects.) [*Post.*] *Arch. f. Anat. u. Physiol.* (*Anat. Abtheil.*) 1886, pp. 388–93 (1 pl.).

Long, R.—**Die Trichine. Eine Anleitung zur Fleischschau.** (The Trichina. A guide to the inspection of meat.) iv. and 31 pp., 20 figs., 8vo, Berlin, 1886.

Pelletan, J.—**Revue.** (Review.)
[Remarks on the progress of microscopical technique and "diatomologie" in 1886.] *Journ. de Microgr.*, XI. (1887) pp. 2–4.

Pennetier, G.—**Technique microscopique. Recherche de la farine de blé dans le chocolat.** (Microscopical Technique. Search for flour in chocolate.) *Journ. de Microgr.*, XI. (1887) pp. 35–7.

Rafter, G. W.—**On the use of the Microscope** in determining the sanitary value of potable water, with special reference to the biology of the water of Hemlock Lake.] *Proc. Rochester (N.Y.) Acad. Sci.*, 1886, 25 pp., 3 pls.

RÜFFERT, F. W.—**Microscopische Fleischbeschau.** (Microscopical inspection of meat.) 2nd ed., xii. and 87 pp., 40 figs., 8vo, Leipzig, 1887.

Seeds for Microscopic Objects.
[Lists of the most suitable by Reymond, Working-Man Botanist, and S. Bottone.]
Engl. Mech., XLIV. (1887) pp. 505–6, 527.

SLACK, H. J.—**Pleasant Hours with the Microscope.**
[Formation of crystals.] *Knowledge*, X. (1887) pp. 107–8 (3 figs.).

VANDERPOEL, F.—**A new Settling Tube for Urinary Deposits.** [*Post.*]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 28–9.

WHELPLEY, H. M.—**The Microscope in Pharmacy.**
["It is undeniable that the Microscope will be one of the important instruments of the drug store of the future. As already referred to, drugs now come into the market in such altered conditions that the naked eye cannot recognize them. This gives great opportunities for adulteration, and microscopy is the most convenient path out of the difficulty. The instrument will grow more and more popular each year, as the profession becomes better educated and the public learns the importance of guarding against inferior or adulterated drugs. Even at the present time the importance to the pharmacist of the study of microscopy is quite generally recognized. The leading colleges of pharmacy have laboratories equipped with facilities for giving the students instruction in this highly interesting and valuable study."]
The Microscope, VI. (1886) p. 280, from *National Druggist.*

WILLIAMS, G. H.—**Modern Petrography,** an account of the application of the Microscope to the study of Geology. 8vo, Boston, 1886.

PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 9th Feb., 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 12th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Crookshank, E. M., Manuel Pratique de Bactériologie basée sur les méthodes de Koch. Traduit par M. Bergeaud. ix. and 292 pp., 32 pls. and 44 figs. (8vo, Paris, 1886)	*The Author.*
Ward, R. H., A.M., M.D., Catalogue of the Microscopical Collection of [ ] with an Appendix for notes, special methods, formulæ, &c., and an Alphabetical Index. (4to, Troy, N.Y., 1886)	„

Mr. Crisp said that the meeting would now be made special, pursuant to notice, in order to move the suspension of the bye-laws for the purpose of re-electing Dr. Dallinger as President for another year.

Mr. Carruthers, P.L.S., said he had great pleasure in proposing that the bye-laws be suspended for the purpose of enabling the Fellows to elect the Rev. Dr. Dallinger for a fourth time President of the Society, and he felt sure that the services he had already rendered, as well as the distinguished position which he occupied in the science of microscopy, rendered it quite unnecessary to say anything further to recommend the motion to them.

Dr. Millar having seconded the motion, it was put to the meeting by Mr. Carruthers, and carried unanimously.

The List of Fellows proposed as Council and Officers for the ensuing year was read as follows:—

President—Rev. W. H. Dallinger, LL.D., F.R.S.

Vice-Presidents—*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; J. William Groves, Esq.; John Mayall, Esq., jun.; *William Thomas Suffolk, Esq.

Treasurer—Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

Secretaries—Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.; Prof. F. Jeffrey Bell, M.A., F.Z.S.

Twelve other Members of Council—Joseph Beck, Esq., F.R.A.S.; Rev. Edmund Carr, M.A.; Frank R. Cheshire, Esq., F.L.S; *Edgar M. Crookshank, Esq., M.B.; *Julien Deby, Esq.; G. F. Dowdeswell, Esq., M.A.; James Glaisher, Esq., F.R.S., F.R.A.S.; *Albert D. Michael, Esq., F.L.S.; John Millar, Esq., L.R.C.P., F.L.S.; Urban Pritchard, Esq., M.D.; *Prof. Charles Stewart, M.R.C.S., F.L.S.; Charles Tyler, Esq., F.L.S.

Mr. W. W. Reeves and Mr. J. D. Hardy having been appointed Scrutineers the ballot was proceeded with, and upon the result being subsequently reported to the President, he declared that all the Fellows who had been nominated were duly elected to serve as Council and Officers during the ensuing year.

* Have not held during the preceding year the office for which they are nominated.

The Treasurer's Account was read (p. 356) by Dr. Beale, F.R.S., who said that the office of Treasurer had been one which imposed upon him a very simple, easy, and pleasant duty, the accounts being in a very satisfactory state; he might, indeed, say that it had almost become a sinecure, owing to the careful way in which the books had been kept by their Assistant Secretary, Mr. West. He would only remark that it was to be hoped that all the Fellows of the Society would endeavour to get as many others to join it as possible, as they wanted more funds, which they could use in a very satisfactory manner.

A motion for the adoption of the Treasurer's Report, together with a vote of thanks to him for his services, was moved by Dr. Millar, seconded by Mr. Glaisher, and carried unanimously.

The Report of the Council was read (p. 355).

The adoption of the Report was moved by Mr. Hardingham, seconded by Mr. Guimaraens, and carried unanimously.

The President then read his Annual Address (p. 185), the latter portion being illustrated upon the screen by means of the limelight lantern.

Mr. Glaisher said he rose with great pleasure to propose to the meeting that their best thanks be given to their President for the most admirable address to which they had just been listening. It was an address which had been interesting from beginning to end, opening out as it did so many suggestions for new researches, all of which were well worth following out by those who were able to do so. He did not need to dwell upon the merits of this address, for it was obvious to every one in that room that their President had been working earnestly to elucidate the questions upon which he had touched, and it was sincerely to be hoped that at a future time they would be permitted to hear the results of a continuance of his labours.

Mr. A. D. Michael said they had all known for a long time something of the extreme thoroughness and patience with which Dr. Dallinger carried out his work when engaged in researches such as those which he had described, but he had never known of any example of it more marked than was furnished by the subject of his address that evening. Accidents, such as they had heard of, were unfortunately common to all research, and though they were very depressing when they occurred, it was very gratifying to know that the experiments were not in this case cut short before a very important result had been attained. They were so well acquainted with the great ability and perseverance of the President as to feel quite certain that if human research could do it, the subject would be pursued until a much more important result had been attained. He had much pleasure in seconding the motion.

The motion was then put to the meeting by Mr. Glaisher and carried unanimously.

The President, in acknowledging the vote, said that he had, on his own part, to thank the Fellows for the honour of his re-election, with reference to which he could only say that he would pledge himself to do his very best in the position they had again called upon him to occupy.

Mr. Crisp moved that the thanks of the Society be given to the Scrutineers and Auditors for their services, and Dr. Millar having seconded the motion, it was carried unanimously.

Mr. A. D. Michael thought they could hardly separate without passing a very hearty vote of thanks to their Secretaries for their very laborious and efficient services rendered to the Society during the past year, services which were so well known and appreciated that he was quite sure that such a proposition needed no recommendation from him.

The President said it gave him great pleasure to second this proposal. When they considered all the work which was done, as well as the very efficient way in which it was done, there could be no doubt as to their great indebtedness to the Secretaries for their services.

The motion was then put to the meeting and carried by acclamation.

Prof. Bell returned thanks on behalf of himself and Mr. Crisp.

New Fellows:—The following were elected *Ordinary* Fellows:—Rev. George Southall, and Miss E. C. Jelly. Mr. P. H. Gosse, F.R.S., was elected an *Honorary* Fellow.

REPORT OF THE COUNCIL FOR 1886.

Fellows.—During the year forty-four Fellows have been elected, a number which is a little below the average of preceding years; the deaths, however, have been somewhat exceptional, so that these, added to the resignations and removals, have reduced the list by thirty-three Fellows.

Of the Honorary Fellows, one vacancy has occurred during the year through the lamented decease of Mr. Busk, whose death was noticed by the President at the October meeting. This vacancy has not yet been filled.

The list at the end of last year stood as follows:—617 Ordinary Fellows, 49 Honorary Fellows, and 82 Ex-officio Fellows, or 748 in all.

Finances.—The revenue of the year for interest, admission fees, and annual subscriptions, exceeded 1000*l.* The net increase of annual subscriptions, due to elections of new Fellows, during the year, amounts to 24*l.* 3*s.*, the invested funds standing at the same amount as last year. The arrears of subscriptions are small, and the Council believe that this Society will compare favourably in this respect with any other Society in London.

The compositions received during the year have been applied in part towards payment of the cost of the portraits of the Presidents, which it had been intended to defray out of the invested funds.

Library and Cabinet.—The Council are glad to be able to report that the Catalogue of the Library is in the hands of the printers, and will be issued during the present session.

In going through the books, it was found that there are many which, whilst valuable in themselves, are not, in the opinion of the Council, sufficiently useful or interesting to Fellows of the Society, to make it desirable to retain them, having regard to the fact that the space in the Library is rapidly being exhausted, and that there is but little room to provide for the necessary books to be purchased in future years. Under these circumstances the Council recommend that they should be authorized to dispose of such books as they may consider it undesirable to retain.

The examination of the Cabinet has been continued, and is still in progress. An exhaustive inspection has been made of the slides, and a considerable number have been repaired and otherwise put in order. For this work the Society are largely indebted to Mr. W. T. Suffolk, who has been unremitting in the attention which he has paid to this matter.

THE TREASURER'S ACCOUNT FOR 1886.

Dr.

1886.	£	s.	d.
To Balance brought from 31st December, 1885	189	14	2
,, Interest on Investments	85	16	6
,, Admission Fees	88	4	0
,, Annual Subscriptions	856	2	11
,, Compositions	157	10	0
,, Journals and Reprints sold by Assistant-Secretary	27	18	6
	£1405	6	1

Cr.

1886.	£	s.	d.
By Rent, Gas, and Attendance	95	15	0
,, Salaries, Reporting, and Commission	194	19	6
,, Books and Binding	91	11	9
,, Expenses of Journal	565	8	2
,, Postage of Journal	83	5	9
,, Portraits of Presidents	98	9	3
,, Stationery and Miscellaneous Printing	48	14	4
,, Coffee at Evening Meetings	20	19	0
,, Petty Cash	36	5	0
,, Fire Insurance	1	10	0
,, Subscription to Mr. Bolton's Bottles	2	2	0
,, New Bookshelves	2	10	0
,, King's College Hospital	1	1	0
,, Balance remaining 31st December, 1886	162	15	4
	£1405	6	1

L. S. Beale, *Treasurer.*

Investments, 31st December, 1886.

1200*l.* Freehold Mortgages. 959*l.* 12*s.* 6*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 25th January, 1887.

Frederick W. Hembry } *Auditors.*
J. J. Vezey

Journal.—It having been found practically impossible to compress the Journal within narrower limits, the Council have consented to an enlargement of the page, so as to give more matter within the same number of pages, and it is hoped that by this means any necessity for an increase in the latter may be obviated. Arrangements have also been made for providing a somewhat thinner paper, so that the bulk of the Journal as a whole will be reduced. The Fellows will understand, however, that the volumes, although apparently smaller that hitherto, contain, in reality, more matter.

The subdivision of the Summary has been carried still further by subordinate headings being given to the Anatomy and Physiology of the Botany section, and also to both divisions of Microscopy, thus facilitating a reference to the notes relating to any given subject.

Meetings.—The interest in the Evening Meetings has been extremely well sustained during the year, the attendance having been larger than in any previous year. The Society are much indebted to the indefatigable exertions of the Secretaries for the subjects brought before the Society, the varied character of which has contributed largely to the interest of the meetings.

Meeting of 9th March, 1887, at King's College, Strand, W.C., Mr. W. T. Suffolk, Vice-President, in the Chair.

The Minutes of the meeting of 9th February last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Bastow, R. A., Mosses of Tasmania, as described in Hooker's Flora of Tasmania, with the addition of forty-three new species from various authors. 64 pp. and 1 table. (8vo, Hobart, 1886) ..	*The Author.*
Castracane, F., Report on the Diatomaceæ collected by H.M.S. 'Challenger' during the years 1873–6. iii. and 178 pp., 30 pls. (4to, London, 1886.)	*Mr. W. T. Thiselton Dyer, C.M.G.*
Slides of *Astrorhiza angulosa* and *Plumularia Wattsii*	*Mr. H. Watts.*

Mr. E. C. Bousfield's note accompanying some photomicrographs exhibited by him was read as follows:—

"The photomicrographs of *Amphipleura pellucida* are not offered as examples of first-rate photomicrographic work, for which mere accuracy of focusing and proper correction of the objective used are by no means sufficient. They will suffice, however, to show what may be expected from the employment of Prof. Abbe's new lenses, and in that respect may prove interesting. The objective employed was a very fine 1/8 apochromatic homogeneous-immersion, N.A. 1·46, projection eye-piece, and the illumination was obtained by a small pencil of very oblique rays from the margin of an Abbe condenser of 1·4 N.A. The illumination of the object, as shown by the darker central portion of the negative, was by no means all that could be desired, but the sharpness of the negative, as testified by the considerable enlargement which it bore, leaves little to be desired, and I hope shortly to be able to bring still more perfect examples

before the Society. Mr. C. Lees Curties effected the resolution of the object; for the remainder I am responsible. The plate used was a Hunter and Sands "Premier," giving about thirty on Warnerke's scale, and the exposure was half-an-hour, though less would probably have sufficed. The light was obtained from a Paragon lamp, using, of course, the edge of the flame.

As an evidence of progress in another direction, perhaps equally important to the photomicrographer, the negatives which accompany the *Amphipleura* specimens may not be without interest. They represent salicine crystals as viewed by polarized light, and the colours were purposely selected to test as severely as possible the capacity of the plate used—a Dixon's orthochromatic. I have employed these plates for such work, with growing satisfaction, for a considerable time. They fail, from exigencies of manufacture and development, at the red end of the spectrum, but even there are far superior to any others with which I have met. The objective used was Zeiss's A, with eye-piece, exposure three minutes or thereabout. Neither negative has been retouched."

Mr. H. Watts's letter was read, accompanying a slide of a rare foraminifer found by him in the Miocene deposits of Victoria, believed to be somewhat unique, as it is the first time it has been found fossil. It was, however, seen on one or two occasions in the 'Challenger' dredgings, but then only two specimens. A second slide sent by Mr. Watts was of the last new species of Marine Hydroida found in Victoria, during 1886, named after the discoverer, *Plumularia Wattsii.*

Dr. Crookshank exhibited two photomicrographs of Flagellated Protozoa in the blood. These photographs were taken with Zeiss's 1/18 homogeneous-immersion from a preparation stained with magenta. The amplification (1750) was obtained by enlargement from the original negatives. They illustrated the employment of the Eastman bromide paper, and the value of photomicrographs for teaching purposes. The flagella and the delicate longitudinal membrane were clearly demonstrated. The negatives were not retouched.

Mr. J. M. Turnbull's sliding nose-piece and adapter, which was awarded a silver medal by the Royal Scottish Society of Arts, was exhibited and described by Mr. Crisp (*supra*, p. 295).

Mr. W. A. Haswell's description of a rotating stage and circular slides for large series of sections was read, and the photographs sent by him exhibited (*supra*, p. 297).

Mr. A. Frazer's centering nose-piece for use with double nose-pieces was exhibited and described by Mr. Crisp (*supra*, p. 294).

Mr. W. Watson exhibited and described the Watson-Draper Microscope, a new instrument which he had made on the designs of Mr. E. T. Draper. The Microscope is an elaboration of the Watson-Crossley form, and the idea of the designer is "that when the object is on the stage, either it may be made to rotate in any direction, horizontal or vertical, round a fixed beam of light without the light ever leaving the object, or

the stage may be kept fixed while the light is revolving round it in any direction horizontal or vertical, always, however, remaining upon the object" (*post*).

Mr. J. Mayall, jun., described the "Nelson Model Microscope," exhibited by Mr. Baker (*supra*, p. 292).

Mr. G. Massee gave a *résumé* of his paper "On the Differentiation of Tissues in Fungi" (*supra*, p. 205).

Mr. A. W. Bennett spoke of the interest attaching to Mr. Massee's paper, inasmuch as so much attention had not been paid to the differentiation of tissues in Fungi as in the higher Algæ, where we often get distinct tissues adapted for assimilation, for conduction, and for strengthening. He did not think, however, that this affected the primary classification of the vegetable kingdom into Cellular and Vascular plants, since it is doubtful whether any true vessels exist in Thallophytes. The cystidia of the Basidiomycetes he did not regard as having any sexual function whatever. They frequently contain large crystals of calcium oxalate.

Professor Stewart said that, although the interest of any structure is naturally greatly enhanced when we are able to recognize the function it performs, we must bear in mind the fact that it may have no duty to accomplish, but be only the result of certain forces acting on the organism, or be but the remains of something of use in past times. Might not the cystidia be produced by the more abundant ascent of fluids through the laticiferous tubes at certain periods, causing an expansion of their free, unsupported extremities; the fluid contents finally escaping either by exuding through the thin walls of the cystidia or producing their rupture?

Drs. H. J. Johnston-Lavis and G. C. J. Vosmaer's paper "On cutting sections of Sponges, and other similar structures with soft and hard tissues," was read by Professor Bell (*supra*, p. 200).

Mr. B. B. Woodward gave some further explanations as to the specimens exhibited in illustration of the paper, which were of exceptionally large size.

Professor Stewart said that large and thin sections of sponges were often of great use by enabling one to determine the natural relationship of distant parts to one another, so that the method described would probably be of chief use in making such sections of the harder sponges. He thought, however, that the simpler freezing method would suffice in most cases. For investigations into the more minute structure, he had obtained the best results by hardening in osmic acid and alcohol, freezing, and cutting with a microtome, and mounting in a solution of acetate of potash, without further staining, or staining with carmine or logwood, and mounting in Canada balsam.

Professor Bell considered that large sections would be found useful in the systematic of sponges, as an assistance to classification.

M. L. Chabry's capillary tube-slide and perforator of cell-elements was similarly exhibited and described (*supra*, p. 319).

Mr. F. Kitton's note on Styrax and Canada Balsam was read as follows:—

"For the last few months I have been using a mixture (equal parts) of

styrax and Canada balsam. The latter was pure, but hardened by exposure to a gentle heat. The styrax ('strained styrax of commerce'), dissolved in benzol and filtered, should be of the consistence of olive oil or a trifle thicker. The refractive index is of course less than that of pure styrax, but higher than that of Canada balsam; it is admirably suited for all the more robust diatoms, from *Eupodiscus argus* to *Pleurosigma angulatum.* It can be hardened over a Bunsen burner without the formation of air-bubbles until it becomes brittle, which, however, is not desirable. Hardening does not materially alter its colour. For the delicately marked diatoms I have found nothing better than tolu. Preparations made two years ago are still free from crystals of cinnamic acid. Prof. H. L. Smith, in the beginning of 1886, kindly sent me some of his own preparations of bromide of antimony in boro-glyceride, together with a score of slides in various other media; many of them were beginning to show crystals; and at this date (December 13th, 1886) the diatoms are obscured by dense crystals. The slides prepared by myself with his bromide of antimony and boro-glyceride, the covers cemented with litharge and red-lead mixed with gold size (the most durable of all cements—I have some insect preparations, mounted in cells 1/12 in. deep filled with dilute glycerin and spirit, as perfect as they were when first mounted twenty-five years ago), are all full of crystals and perfectly useless. This is much to be regretted as in every other respect this medium left nothing to be desired. With a dry 1/6 in. of Ross the lines on *Surirella gemma* were easily resolved into dots, and those on *P. angulatum* could be seen with an old Ross 1/4 in. of 74°. I have several of Dr. Meates' sulphide of arsenic mounts, but they are spoilt by crystallization."

The following Instruments, Objects, &c., were exhibited:—

Mr. C. Baker:—Nelson Model Microscope.

Mr. Bolton:—*Pedicellina cernua* var *glabra.*

Mr. E. C. Bousfield:—Photomicrographs of *Amphipleura pellucida* and Salicine Crystals.

Mr. Crisp:—(1) Turnbull's Sliding Nose-piece and Adapter; (2) Frazer's Centering Nose-piece; (3) Chabry's Capillary Tube-slide.

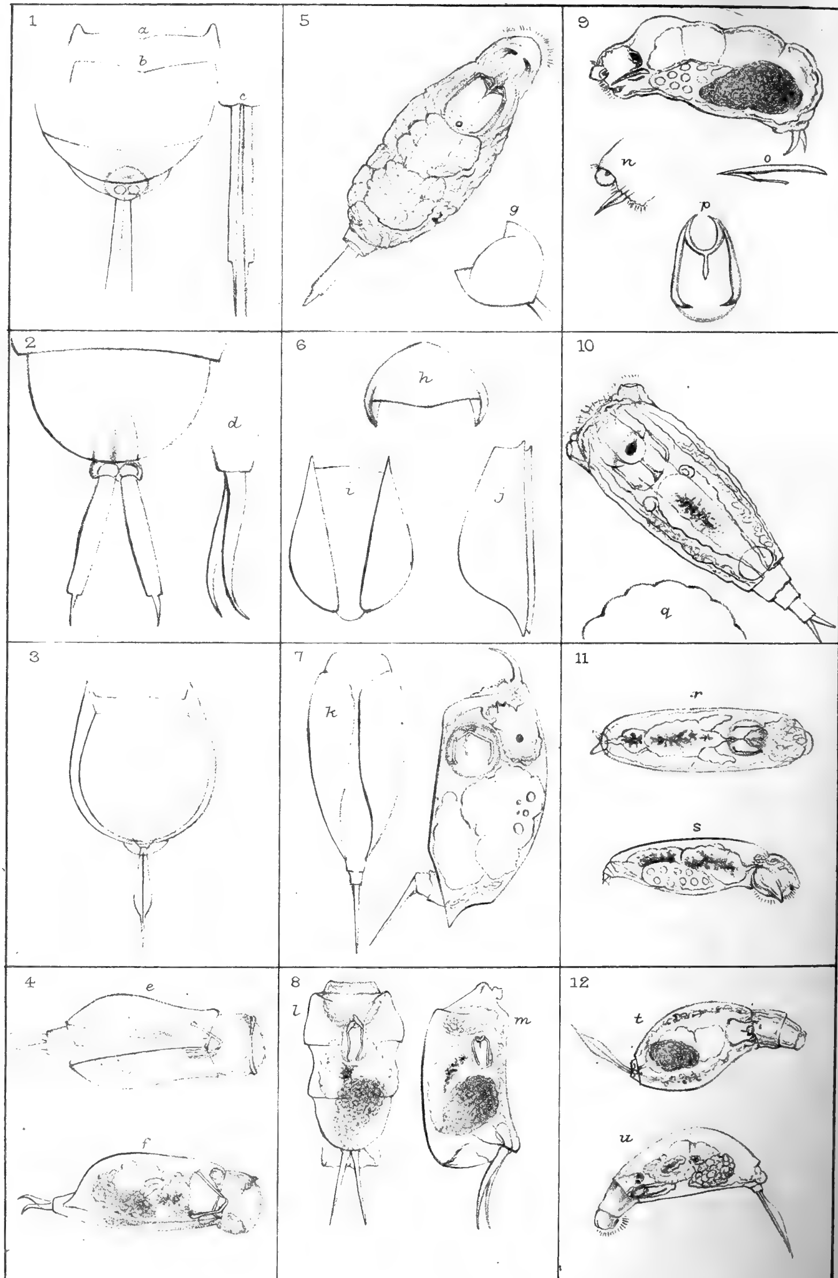
Dr. Crookshank:—Photomicrographs of flagellated Protozoa in the blood.

Drs. H. J. Johnston-Lavis, and G. C. J. Vosmaer:—Sections of sponges in illustration of their paper.

Mr. W. Watson:—New Microscope designed by Mr. E. T. Draper.

Mr. H. Watts:—Slides of *Astrorhiza angulosa* and *Plumularia Wattsii.*

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. E. B. L. Brayley, W. Lynd, W. Stratford, M.D., A. E. Weightman, Surg. R.N., H. Weld-Blundell, R. Henslowe Wellington, and W. P. Young.



P.H.G. del. ad nat.

West, Newman & Co. lith.

New Rotifera.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1887.

TRANSACTIONS OF THE SOCIETY.

VIII.—*Twelve New Species of Rotifera.*

By P. H. Gosse, F.R.S., Hon. F.R.M.S., &c.

(*Read* 13*th April*, 1887.)

Plate VIII.

I beg to add diagnoses and figures of a few more Rotifera, supplementary to those described in this Journal, *ante*, p. 1.

1. *Cathypna angulata.* Generally, like *C. luna*, but occipital edge of lorica nearly straight; pectoral edge indented in the middle: toe rod-shaped, straight, very slender; claw one-shouldered, one-third of toe's length. Length, total, 1/85 in. Lacustrine.

This is more than twice as large as *C. luna.* Moreover, the frontal edges of the lorica are nearly *straight*, between very slight lateral points, and *alike*, save that the line of the pectoral edge (fig. 1, *b*) descends from each point to a medial angle, just perceptible. Then, the hind extremity of the dorsal plate allows the partial emission of a great protuberant shelly boss, as in *Monostyla bulla*, behind and beneath which is the globose foot-bulb. Again, the rod-like toes are even straighter and slenderer than in *luna*, and the claws are much longer in proportion. Parallel-edged to two-thirds of their length, a right-angled shoulder, on the outer side, reduces the width by one-half; and the remainder (the claw) tapers to a long-drawn acute point (*c*). When rotating, the truncate front is three-lobed, much as in *luna;* but there is seen beyond and above this a very subtile clear glassy hood, having a rondo-conic outline, protrusile and retractile.

EXPLANATION OF PLATE VIII.

Fig. 1.—*Cathypna ungulata;* hind end of lorica. *a*, occipital edge; *b*, pectoral edge; *c*, toes.
Fig. 2.—*Cathypna diomis;* foot and toes, dorsal; *d*, toes, seen from the *left.*
„ 3.—*Cathypna latifrons;* dorsal.
„ 4.—*Diaschiza globata;* *e*, dorsal; *f*, lateral.
„ 5.—*Monostyla mollis;* dorsal; *g*, contracted.
„ 6.—*Dapidia stroma*, lorica; *h*, transverse section; *i*, ventral; *j*, lateral.
„ 7.—*Colurus leptus;* lateral; *k*, ventral outline.
„ 8.—*Diglena* (?) *pachida;* *l*, dorsal; *m*, lateral.
„ 9.—*Diglena suilla;* lateral; *n*, jaws protruded; *o*, jaws, lateral; *p*, jaws, dorsal.
„ 10.—*Notommata potamis;* dorsal; *q*, transverse section of back.
„ 11.—*Proales othodon;* *r*, dorsal; *s*, lateral.
„ 12.—*Proales prehensor;* *t*, dorsal; *u*, lateral.

I have seen this form only from Woolston Pond, and only on one occasion. (Plate VIII. fig. 1.)

2. *Cathypna diomis.* Generally, like *C. luna,* but lorica much elevated behind, and ending there abruptly; followed by a wide hemispheric joint: toes slightly blade-shaped; claw two-shouldered, short, recurved. Length of lorica 1/260 in.; total, expanded, 1/150 in. Lacustrine.

A rather remarkable little form. The carapace, broadly ovate, is unusually arched, and abruptly truncate just behind its greatest elevation; whence another wide rounded plate descends, as if to make the carapace two-jointed.* The foot, narrow, but a little widened at its end, just protrudes from under this plate, and bears the toes, jointed to it with small round condyles. They are almost rod-shaped, but there is a hardly perceptible curvature of their lateral margins. But the most noteworthy feature is that *both* the lateral margins of each toe are abruptly shouldered; and the little claw-like remainder has the acute tip recurved (*d*). The mallei are long, strongly elbowed, and unusually slender. An eye, of moderate size, richly coloured, lies far down in the occiput. The dorsal plate is coarsely tesselated, as in *C. rusticula.* Several specimens have occurred in water sent to me by Mr. Hood, from Black Loch, near Dundee. (Fig. 2.)

3. *Cathypna latifrons.* Lorica broadly ovate, the frontal edges little diminished, both straight; the occipital much wider than the pectoral: toes broadly blade-shaped, much produced, not shouldered. Length of lorica 1/260 in. Lacustrine.

Another of the rarities of the prolific Black Loch. The outline is that of *C. rusticula,* if we suppose the anterior fourth of the lorica to be cut off transversely. But the ventral plate is less in area, *all round,* than the dorsal, especially forward, narrowing more rapidly, and terminating lower down. There is a considerable rounded boss behind, as in both the preceding, below (or within) which are the foot-joints, but not protruded. The toes have the inner edge straight, and the outer *much* outcurved; so that, when they are held in contact (as they usually are), the pair present an outline widely fusiform. Then the points are drawn out to great length and tenuity, with an effect very peculiar. The front of the lorica forms two stiff lateral points; within which the margins, both occipital and pectoral, seem to be thinned-off to very delicate membranes, so as to be capable of extension and retraction. When closed, the occipital edge is, I think, straight from point to point, and concave inward. Then the pectoral edge is appressed to the concave dorsal surface (*but at a lower,* i. e. *a hinder, level*); and that so close as to be indistinguishable from it, even by most careful focusing with high powers. The internal organs seem normal. (Fig. 3.)

4. *Diaschiza globata.* Body sub-pyriform, becoming globose in contraction: front round, girded by a prominent ring: lorica dorsally cleft by a wide, but shallow furrow, whose edges rise to slight ridges: foot stout; toes slender, produced, acute, slightly decurved. Length 1/200 in. Lacustrine.

The shallow dorsal cleft, having a V-shaped section, is well seen, as

* This represents the "shelly boss" of the preceding species, and may possibly be, structurally considered, the basal joint of the foot abnormally developed.

the creature crawls about the weeds, the edges turned up slightly; while the sides of the lorica end ventrally in straight lines, produced behind into small obtuse points. The integument appears sometimes quite flexible. The bluff rounded head, clothed with simple cilia, is surrounded by a prominent ring or collar, not always observable. An occipital brain seems destitute of any eye-spot. The toes are delicately attenuated to long points, which, *more generis*, are often thrown back, though the points are decurved.

The little animal is active and restless, moderately swift in swimming, with frequent augmentations of speed, sudden and sustained. It soon dies in a *live-box;* and, in dying, usually contracts itself into a globular form. Sometimes it spins swiftly round and round, in a circle of which the toe-tips are the centre. I have examined some eight or ten specimens, all in water sent by Mr. Hood from his aquarium at Dundee. (Fig. 4.)

5. *Monostyla mollis.* Body oblong, sub-cylindric, clothed with a soft, flexible, corrugated skin, instead of a lorica: toe rod-shaped, short, thick; claw obscurely two-shouldered. Length 1/250 to 1/200 in. Lacustrine.

I venture to claim specific rank for this form, which has the same relation to *Monostyla* as *D. flexilis* has to *Distyla* and *Cathypna.* That both are immature conditions would be a natural conclusion, but that, so far as my experience goes, all Loricate Rotifera are hatched with the lorica already developed. And that such is the case with *Monostyla* in particular, the following note will show. The facts, apart from their relation to this question, may be of interest.

In August 1885, an egg of *M. cornuta,* in my live-box, displayed the young moving vigorously within the hyaline egg-shell, slowly revolving. The lorica was already well defined, evidently without folds, though expansile in retraction, distinctly broad-oval in outline, smooth and rotund when viewed lengthwise. The imprisoned animal grew much larger, so that it almost filled the long diameter of the shell, but not nearly its short diameter. Its length was now 1/400 in.

After I had watched for about an hour, during which its restless motions had nearly ceased, the frontal cilia were seen vibrating at the very edge, and in a moment more *outside* the edge, of the shell. For an instant it recoiled; but returned again and again to the effort, at each time protruding more and more. At length it pushed fully half out, then hung a moment, as if exhausted. Now another vigorous lashing of the cilia, and out it is bodily, yet still adhering to the shell by the glutinous toe-point, whereby it now drags the shell hither and thither. At last it is quite free, evidently ovate, stiff and smooth, as the normal adult.

These facts, which were recorded during the actual process, seem sufficient to show that, in this Family at least, the chitinous consolidation of the lorica is attained before birth. And the corollary follows, that, in *D. flexilis* and *M. mollis* we have examples of illoricate condition in a loricate family, analogous to *Mastigocerca stylata* in the *Rattulidæ.*

I have examined many specimens from various waters. In one case the animal contracted to a cordiform outline *g*, as if possessing a

lorica, which yet was very membranous. When eagerly chewing, not only the mallei worked, but a pair of additional horn-like pieces, well in front of the mastax. A very small and indistinct red eye is near the occipital extremity of the brain. (Fig. 5.)

6. *Dapidia stroma.* Outline ovate, dorsum high, rounded: carapace much exceeding the viscera in width, and turned-in beneath with straight margins; viscera protected exclusively by membrane. Length 1/65 in. Lacustrine.

Dr. Hudson (Rotifera, ii. 89) has alluded to my opinion that certain species of *Euchlanis* are generically separable by the character of wanting a ventral plate; the lateral edges of the carapace, which turn in beneath, being united only by flexible and expansible skin. My esteemed colleague differs from me; and, on a matter so exceedingly delicate and difficult to determine, I may be in the wrong. But I am not convinced; and I hope it is not inconsistent with modesty or friendship to record my own judgment. The *species,* I think, is undescribed, whatever its generic place.

The carapace is shaped (if I may use so homely a comparison) like a boat turned bottom up, her bows cut off sharp, her gunwale curved-in, and no keel. Suppose the cavity of the boat to be loaded, *half-way up,* with goods [the viscera], and a tarpaulin [the common skin] to be spread over all, but higher in the middle than at the sides; the head-mass, of living fleshy organs, to be thrust out at the truncate and open bow, filling it; and the foot and toes to represent the rudder;—a fair idea will be conceived of this fine form. There are no foot-setæ.

It may easily be supposed to possess a ventral plate. But what looks like one, on a (nearly) lateral view, is the edge of the farther incurved side of the carapace; when viewed *from behind,* there is no lateral infold or sinus running longitudinally. I have seen numerous examples. (Fig. 6.)

7. *Colurus leptus.* Lorica, in dorsal aspect, long oval; in lateral aspect, abruptly excavate behind; dorsal hind points, acute: ventral cleft close, insensibly expanding to a long pyriform foot-orifice: toe a slender style, apparently undivided; foot and toe about half as long as lorica: one large eye in occiput. Length, extended, 1/300 in. Lacustrine *and marine.*

A marked character, very easily recognizable, is the hind excavation of the lorica, as if a slice had been cut clean out. Examples with this peculiarity are quite common, both from weedy fresh waters, and from rock-pools on our northern and southern coasts. And I can trace no difference between them, save that the marine examples may be a trifle stouter in outline. The toe is a slender produced point, I will not say indivisible, but not, in my experience, divided. Several oil-globules are usually present in the dorsal part of the visceral cavity. (Fig. 7.)

8. *Diglena* (?) *pachida.* Body thick, sub-cylindric, very variable in outline: skin leathery, thrown into strong folds: eye wanting: toes two, furcate, long, slender, acute, decurved. Length 1/87 in. Marine.

Several examples of this curious thickset form,—more remarkable than attractive,—occurred to me last summer, in sea-water from various rock-pools in Torbay. It is uncouth, heavy and sluggish, apparently

illoricate, but inclosed in integument which seems of leathery stiffness, making stout, transverse folds, whence the fore and hind parts project at intervals. The head, at extreme protrusion, shows a thread-like frontal proboscis, an ample brain, but no eye, and trophi which appear slight and very simple, but need further examination. The toes, long and slender, have that backward direction which is seen in many *Diglenæ*, yet have a forward curve. The internal organs are nearly lost in an indistinguishable granulation.

Its generic affinities are very doubtful. It is not improbable that a more matured acquaintance may elevate this strange form to the rank of a genus. In any case it is a notable addition to our marine Rotifera. (Fig. 8.)

9. *Diglena suilla.* Body cylindric, or fusiform, massive, often gibbous in the middle: face broad, sub-prone, with small, tubercular frontal proboscis: eye large, cervical: foot thick, short: toes minute, decurved. Length 1/200 in. Marine.

This thick-bodied, plump, snouted, swine-like creature occurred in a number of examples, among conferva much crowded with groups of diatoms, in sea-water from Invergowrie. The body rises into successive swellings, divided by sharp constrictions, like that of a full-fed caterpillar, diminishing abruptly to an oblique thick head, with a distinct round pimple in front, in which is a very minute refractive corpuscle, like a glass bead. This, however, is probably not an eye, the true eye being large and conspicuous, near the tip of an ample brain. The front is truncate, but appears semi-prone, from the inclination of the head; it is ciliated on its whole surface, the cilia *surrounding* the globose proboscis, not *covering* it. The jaws (*o p*) are of the same form as in other *Diglenæ*, as *permollis;* viewed laterally, they are produced into a long point, which is often deliberately projected (*n*) and retracted. Young specimens lack the plumpness of adults, especially in the hinder parts. The stomach is of great size, usually gorged with green granular food. The animal, in habit, is very sluggish. (Fig. 9.)

10. *Notommata potamis.* Of large size, sub-cylindric, gradually tapering to the foot: brain clear, obscurely three-lobed: head broad, with conspicuous *oblique* auricles: trunk strongly fluted: foot long: toes short, pointed. Length 1/90 in. Lacustrine.

Having much in common with *N. naias*, both in general form and in details, this presents characters which appear to mark it as specifically distinct. In more than a dozen examples which I have examined, alive and dead, from Woolston Pond and other waters, these distinctive features were seen. The auricles are large and strongly marked, extruded freely, and so remaining even in death, having the form, not of *hemispheres*, but of short truncate *columns*, thrust out *obliquely*, so as to make the whole head obconic. A great clear brain shows a tendency to triplicity; the middle sac bears a conspicuous red eye on its inner surface, above its swelling. The whole body is fluted strongly, about twelve deep incisions running longitudinally throughout, so that a transverse section would show so many rounded elevations (*q*). The stomach has a pair of minute ovate glands, is very large and saccate, with a distinct intestine. The last joint of the trunk forms a globose saccate sort of tail, over

and behind the first joint of the foot, not unlike that of *Copeus pachyurus.* The branchial system displays thick convolute vessels and a small contractile bladder. The whole animal, in life, is often tinged with delicate yellow, of deeper hue in the stomach. Several specimens which seem to belong to this species, recently obtained (April 1887) from a pond near my residence, have the head of an orange hue, the front half of the mastax of a transparent crimson, and the eye of a rich ruby-red; the whole giving a most attractive appearance to the animal, which is, moreover, very vivacious in manner. (Fig. 10.)

11. *Proales othodon.* Body nearly cylindric, but arched in the line of the back, straight in that of the belly; very plump throughout: mastax forcibly protrusile: foot and toes minute. Length 1/144 in. Lacustrine.

This also occurred in water from Woolston—a single example only. It is of plump hog-like form, without wrinkles, and almost without folds. It has no very marked characteristics, yet it does not seem referrible to any recognized species. There is a slight projection from the front in a lateral view (*s*), which, however, in a dorsal view (*r*) appears to be a wide ridge seen endwise. The face is obliquely prone, from the midst of which the jaws are occasionally protruded, with force, in the manner of a fierce *Diglena:* the details of these jaws I was not able to trace. A sac-like brain is conspicuous, but I could discern no eye. The stomach and distinct intestine are ample; the former carries a pair of gastric glands, which are large, high, and pointed. (Fig. 11.)

12. *Proales prehensor.* Body bottle- or oil-flask-shaped, but with the belly nearly flat; fore parts long, very protrusile; eye small; face prone: a short tuberculous tail: foot short; toes blade-shaped, straight, acute, usually appressed. Length 1/173 in. Lacustrine.

I have doubts where I should place this species. Technically, it seems a *Notommata* or *Proales,* with the form of a *Distyla,* yet having much in common with *Distemma.* The toes, in particular (see *t*),—blades, widest in the middle, with slender produced tips, and generally carried close together as one (though sometimes widely spread),—remind us forcibly of *Distyla* or *Cathypna.* The trophi, too, suggest the same alliance: viewed ventrally, the length and form of the mallei, and the triradiate incus, for instance:—yet I believe I have seen a great blade-like prolongation of the incus arching far into the occiput; and, at times, what seemed a short forcipate form of the rami, as in *Diglena* and *Distemma.* There appears a sort of proboscis, but close appressed, not at all movable. I have never seen the jaws protruded, though they are every moment brought to the bottom of the ciliate face, snapping up atoms of food.

It is not much given to locomotion, but can swim, rather slowly: usually, it rolls hither and thither, or adheres by the toes. It picks industriously among the vegetable floccose for morsels of food: it is vivacious and energetic, and altogether attractive; constantly reminding me of the marine *Distemma raptor.* I have observed, in all, about a score of examples, all isolated, in water courteously sent me by Miss Davies, from Woolston Pond. (Fig. 12.)

Corrigenda et addenda.

Monura micromela, Gosse (this Journal, *ante* p. 7). Since this was published I have seen the toes widely expanded. The species must, therefore, be transferred to *Colurus*.

Furcularia marina, Duj. (H. & G. Rotif., ii. 44). I have lately seen two pectoral eyes, pale-red, well-defined, one on each side of (but behind) the mastax. The species must, therefore, be transferred to *Distemma*, with which genus the trophi agree.

Triophthalmus dorsualis, Ehr., a noble species, I have lately found in a pool near my own residence, agreeing accurately with Ehrenberg's figure.

Anuræa 4-dentata, Ehr. I have identified in water sent me by Mr. Bolton from Birmingham.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Mechanism of Development.‡—Dr. W. Roux continues his researches on the mechanics of embryonic development. The present contribution, which is the fourth of the series, is specially devoted to the investigation of the manner in which the disposition of the median plane of the frog embryo is determined by the direction of conjugation of male and female nucleus.

(*a*) In normal conditions, when the ovum is unconstrained and when it has not been altered by too long delayed spawning. (1) The unfertilized ovum has only one main direction of the future median plane of the embryo determined—by the bipolar arrangement of the yolk-material. The axis from black to white pole represents the dorso-ventral direction of the real, the cephalo-caudal direction of the final embryo. (2) Of the meridian planes through this egg-axis, that in which the two nuclei conjugate becomes the median plane of the embryo. (3) But the direction of conjugation is not fixed, but may be displaced by "localized fertilization" to any meridian. (4) The fertilized side of the ovum becomes the ventro-caudal side of the embryo, the other the dorso-cephalic.

(5) The first division of the segmentation nucleus occurs in the direction of conjugation. The separation of the two halves takes place at right angles to the direction of division. (6) The coincidence of the direction of conjugation and plane of division has this functional import, that only in this case is the effect of conjugation subject to no miscarriage by the division. It expresses the simplest mechanism of the division of masses united, but not completely mixed in conjugation. (7) The first yolk division occurs in the meridional plane parallel to the direction of conjugation, and eventually coinciding with it. (8) The direction of conjugation determines the direction of the first segmentation of the nucleus, that the first yolk-division, and eventually the disposition of the embryo in the egg.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Arch. f. Mikr. Anat., xxix. (1887) pp. 157–212 (1 pl.).

(9) The process of conjugation exhibits two typical intraoval courses, first an approximately radial course which leads the sperm from the point of penetration on the black margin, deep into the ovum, to the "nuclear layer" of the yolk, and second, a nucleopetal course which conducts the two nuclei towards one another within the "nuclear layer," but especially the sperm nucleus to the female.

(*b*) When the ovum is forcibly fixed with the axis oblique. (10) If the inclination be but slight (20–30°), the above statements often hold good. (11) The yolk-material is disposed in such a way that it lies symmetrically in relation to the first plane of division determined by the direction of conjugation. (12) If the inclination be greater, the influence of gravity on the yolk produces a symmetrical disposition of the different material, and this influences the first division in such a way that the plane of division is definitely disposed to the plane of symmetry, either lying in it or at right angles to it. (13) Here also the first nuclear division apparently occurs in the direction of the conjugation of the nuclei. (14) The position of the germinal vesicle is influenced by the obliquity of the axis, and the course of the sperm by the streaming of the yolk in such a way that the conjugation must often occur in a direction approximately transverse to the plane of symmetry in the oblique ovum. Thus there results a frequent approximately transverse direction of the first segmentation. (15) But since the first segmentation is most frequently either quite transverse to the plane of symmetry or exactly in the same direction, it is necessary to suppose a twisting action of the symmetrically disposed yolk on the segmentation nucleus, during or after conjugation. This turning may be supposed to occur so that the segmentation nucleus and its direction of conjugation become either parallel or perpendicular to the plane of symmetry, according as the line of conjugation is nearer one or other. (16) If the segmentation nucleus and line of conjugation be turned into the plane of yolk symmetry, the first nuclear division separates the material of the two antimeres of the embryo, and the first plane of yolk division is the median plane of the embryo. (17) If the turning result in a position perpendicular to the above, the first nuclear division separates the nuclear material, as in a normal second segmentation, into what ultimately become ventrocaudal and dorsocephalic portions. (18) With greater obliquity of egg axis the side of the depressed black pole becomes always the ventrocaudal side of the embryo. With slight obliquity this tendency may conflict with that determined by the position of fertilization (cf. 4 and 8), and the fertilized side become the ventrocaudal, but this is only if the rearrangement of the yolk occur in such a way that, at the time of second segmentation, the egg axis has its black pole inclined towards the sperm. (19) The primary cause for the position of the ventrocaudal surface on the side to which the upper end of the egg axis is inclined is probably the accumulation of formative yolk on that side.

Origin of Segmental Duct.* — Prof. A. C. Haddon summarizes the history of the discovery of the epiblastic origin of the primitive duct of the vertebrate excretory organ, and alludes to the difficulties which have hitherto beset the interpretation of its morphology.

Accepting the proposition that in primitive Chordata the nephridia were segmentally arranged and opened directly to the exterior, we have only to assume that the lateral area along which they opened was grooved and that this groove extended posteriorly as far as the anus. From the analogy of the neural groove, there is no great difficulty in further supposing that the

* Proc. R. Dublin Soc., v. (1887) pp. 463–72 (1 pl.).

nephric groove was converted into a canal, which, becoming separated from the overlying epiblast, might sink into the deeper-lying parts of the body. We are justified in assuming the persistence of the blastopore as the anus in early Chordata; thus, if the nephric groove were continued round to the anus, it would practically open into the extreme hinder end of the mesenteron, in other words into the urodæum (Gadow). Probably about the same time that the nephric groove was being converted into the nephric canal (segmental duct) the proctodæum was being invaginated. The latter would push before it the posterior orifice of the nephric canal. The nephridia themselves appear to be of mesoblastic origin. On the hypothesis just sketched out, the nephridia always open by their original epiblastic pores—primitively, directly to the exterior; secondarily, into a canal separated from the epiblast: also the archinephros could be equally effectively functional throughout the whole period of its modification.

Embryogeny of Anthropoid Apes.*—Dr. J. Deniker has been able to study the fœtus of the gorilla and the gibbon, which he compares with that of man. Especial attention is given to the proportions of the limbs, and it is shown that while in man, during the earlier stages of embryonic life, the lengths of both extremities are almost equal, in the anthropoid apes, at even an early period, the length of the upper exceeds that of the lower limb. The frontal region of the skull ossifies more rapidly, and the occipital and petromastoid portions more slowly in anthropoid apes than in man. The encephalon of the fœtal gorilla weighed 28 grammes, or one sixteenth of the weight of the whole body; in both fœtûs the cerebellum was very small and completely covered by the cerebrum. The relative and absolute dimensions of the brain of the fœtal gorilla correspond to those of the human fœtus at the fifth month, but in its convolutions it was equivalent to those of the human fœtus at the sixth month. The dentary follicles of both gorilla and gibbon are developed earlier than in man; in the gorilla the teeth of the upper appear before those of the lower jaw, or in the reverse order to what ordinarily obtains in man. The cæcal appendage appears to increase relatively to age in the gorilla, while the contrary is the rule in man.

Segmentation of Frog Ova in Sublimate Solution.†—Herr T. Dewitz, in reference to a report by Tichomiroff as to parthenogenesis artificially induced in the eggs of *Bombus* by mechanical and chemical irritation, notes that he observed unfertilized frog ova to undergo segmentation in sublimate solution. In some cases one segmentation has occurred, in others several; in some cases irregularly, in others normally. The ova experimented on were those of *Rana fusca*, *R. esculenta*, and *Hyla arborea.* The segmentation occurred alike when the ova were left in the solution, or simply dipped in it for a few minutes and then put into water. In the latter case the segmentation became slowly evident, so that the suggestion of its having been preformed is not adequate. No spontaneous segmentation has been observed, so that if the observations be correct the sublimate acts as a stimulus.

Hybridization between Amphibia.‡—Prof. G. Born has continued his researches on the hybridization of Amphibia, and after a long series of experiments has reached a number of interesting results.

(1) Crossing is possible in many cases, in three cases reciprocally. The

* 'Recherches anatomiques et embryologiques sur les Singes Anthropoïdes,' Paris, 1885. See Nature, xxxv. (1887) pp. 509–10.

† Biol. Centralbl., vii. (1887) pp. 93–4.

‡ Arch. f. Mikr. Anat., xxvii. (1886) pp. 192–271 (3 pls.).

degree of development reached by the hybrid fertilized ova varied greatly. Fertilization was sometimes effected without any result. In other cases the ova reached the stage of segmentation, and that to a varying extent. A third degree was exhibited by those which survived till the closure of the blastopore. When this was so the preceding segmentation was perfectly regular. Many larvæ die soon after liberation, a few survive.

(2) In hybridization between *Rana fusca* m. and *R. arvalis* f., and between *Bufo variabilis* m. and *B. cinereus* f., the larvæ survived metamorphosis; in the latter the hybridization is readily successful, in the former only in a small minority of cases.

(3) In amphibians hybrid fertilization occurs most readily when the reproductive elements of both sexes are in perfect maturity. The sperm retains its potentiality only a very short time in relation to the ova of some species, for a very long time in relation to those of others. These conclusions are compared with those of Pflüger and Hertwig.

(4) The result of hybrid fertilization between *R. fusca* m. and *R. arvalis* f. depends greatly on the concentration of the sperm-fluid. The more dilute, the fewer sperms are there to overcome the difficulties of effecting entrance. Probably, too, the sperms have lost some of their energy. The obverse statement that the more concentrated the sperm-fluid, the more spermatozoa should enter the ovum, was beautifully verified by direct observation. Born has proved that the presence of more than one sperm-nucleus within the ovum is usually at the greatest hazard of normal development. All the more marked irregularities in hybridization are referable to polyspermy; when regular and simple segmentation and development have occurred, it may be conversely inferred that only one spermatozoon has entered. As in normal fertilization, the ova have the power of refusing sperms after one has entered. In most cases, after a certain stage is passed, the divergent tendencies of ovum and sperm seem no longer organically compatible, and a paralysis of development ensues. Life and continued development are coincident.

(5) It is difficult to determine whether cases of successful development after hybrid fertilization occur normally. *Bufo variabilis* m. and *Bufo cinereus* f. are often found copulating, but the result is only known to be successful in the above artificial experiments.

The research closes with some notes on the manifold obstacles to successful hybridization, on hybridization in general, and on the suggestiveness of such inquiries as to the pathology of reproduction in relation to the normal processes.

Origin of Periblast in Teleosteans.*—Dr. J. H. List reports the results of some observations made in 1884 on the formation of the periblast in *Crenilabrus tinca*, *C. quinquemaculata*, and *C. pavo*. The first part of the paper is occupied with an historical review of the relative researches of Agassiz and Whitman, Kupffer, Wenckebach and others.

Ten hours after fertilization the blastodisc is seen as a cap on the yolk, with its margin still more than thirty degrees from the equator. Along the whole margin cells stretch out towards the yolk and are constricted off. After separation from the margin these cells arranged themselves in concentric rows. They remain separated by interspaces, and the cells of one row correspond to the interspaces of the next. Certain irregularities must however be allowed. The cells are all oval, and lie with their long axis parallel to the blastodisc margin. Between them there are abundant fat globules thickest close to the margin of the blastoderm. Dr. List regards

* Biol. Centralbl., vii. (1887) pp. 81–8.

these constricted off periblast elements as cells, and not nuclei. Sections made at a later date confirmed his observations on the living objects.

Only three layers of cells at most were seen round the blastodisc margin. On sections, thirty-two hours after fertilization, there was seen below the blastodisc a single layer of cells, distinctly flattened and stretching like a flat epithelium from one margin to the other. The component cells had distinct nuclei, many somewhat larger and more spherical than those of the blastoderm. From the section Dr. List inferred that the constriction of periblast cells took place not only outwards, but also inwards below the blastoderm to form the layer just noted. How long the external budding off goes on was not determined. Without regarding the available data as adequate, the author is inclined to believe that the hypoblast arises from the periblast.

Formation of Double Monsters.*—M. C. Dareste has a note on recent researches on the mode of formation of double monsters. He allows that there are double monsters as to which his explanation by the formation of two embryonic bodies from a single cicatricula will not apply; these, which have been inexactly called monsters by lateral union, are only partially double; they are very rare among birds, but are pretty frequent among fishes after artificial fecundation. Here even there is initial duality, but the fusion takes place very early, even, he thinks, before segmentation. And he suggests that an explanation is to be found in the history of the process of fecundation; if the single fertilizing spermatozoon forms the male nucleus, would not two spermatozoa give rise to two male nuclei, or, in other words, to two foci of embryonic formation?

β. Histology.†

Chemistry of Cell-nucleus.‡—Herr A. Kossel finds that when yolk nuclein is broken up by boiling dilute acids it does not form guanin and hypoxanthin as does nuclear nuclein. Adenin is a new base formed in the decomposition of the nuclei of the pancreatic gland, and appears as an intermediate product in the formation of hypoxanthin, into which it passes under the action of nitric acid; it has been found in numerous animal and vegetable cells.

Death of Muscles.§—After death, when the muscles have ceased to respond to electrical or mechanical stimulus, there still remains a certain irritability. It is still possible to provoke contractions of final agony, which end finally in a particular form of rigidity. M. C. Rouget has studied these last manifestations of life in muscle. A small detached portion was placed on an object-glass in a drop of 6 per cent. salt solution, and the fibres teased apart. The stretched fibres contract like caoutchouc when the tension is relaxed; they twist variously when freed, with greatest rapidity in birds, mammals, and fishes among Vertebrates, and in Orthoptera and Crustacea among Invertebrates. The most leisurely movements were observed in *Hydrophilus*.

At the free extremity of the fibres a local contraction takes place, and similarly at all points where the fibres have been pressed or lacerated. In Arthropods these gradually encroach on the rest of the fibre. In frogs and lizards, after the appearance of the pads of contractions, ruptures occur,

* Comptes Rendus, civ. (1887) pp. 715-7.
† This section is limited to papers relating to Cells and Fibres.
‡ Zeitschr. f. Physiol. Chemie, x. (1886). See Bot. Centralbl., xxix. (1887) p. 39.
§ Comptes Rendus, civ. (1887) pp. 1017-20.

and the whole fibre is divided into blocks separated by empty spaces within the sarcolemma. In the blocks the transverse striæ are very closely approximated. These ruptures are the result of violent convulsive tension between the contracted and the adjacent passive portions. The first pads of contraction are the consequences of a mechanical excitation of the isolated fibre; the spreading of the contraction is due to the gradual imbibition of a foreign irritant fluid in the interstices separating the fibrils. The appearances thus artificially produced are strikingly like those seen in the dead muscle of typhoid, variola, and cholera patients. In fishes, chelonians, birds, and mammals, the direct imbibition is so rapid that the preliminary contracted pads seem to be absent. Annular swellings appear separated by constrictions, and forming an irregular transverse striation. Even in muscles apparently quite rigid, after some days, in frogs and lizards, living and contractile fibres may be found among the dead. At the commencement of rigidity the same mixture may be observed in mammals. Elasticity and contractility are lost at the same moment.

B. INVERTEBRATA.

Singular Parasite on Firola.*—Dr. J. Barrois describes a unique parasite found on the surface of *Pterotrachea coronata* in the Gulf of Villefranche. The body of the animal was red and opaque, the form triangular, the structure unique.

(1) The alimentary system consists of three distinct sacs, opening separately to the exterior at the ends of the arms. They were capable of suction by means of three muscle bundles inserted on three hyaline cords adhering to the wall of the sacs. Each sac exhibited a thick epithelial lining surrounded by a strong muscular envelope. (2) A water-vascular system was present, communicating with the interior and with the cavity of the sacs viâ the terminal claw. A partitioned central organ gives off three canals radiating to the ends of the arms. (3) The integument consisted of an external cuticle, an epithelium, rounded mesenchymatous cells, and an internal more delicate cuticle. (4) The claw at the end of each arm exhibited three chambers, communicating on the one hand with the endodermic sacs and the water-vascular system, and on the other with the exterior by means of a single terminal aperture. (5) There is a nervous system consisting of a thick trunk connecting the sensory plates formed by a thickening of integument at the root of each arm in the concave portion of the disc. Two fibrous cords extend from the dorsal face to the mass of areolar tissue above the partitioned central organ. They are bounded to right and left by an albuminous nucleated mass. The skeleton was unfortunately lost in preparation.

The only suggestion that Dr. Barrois can offer is that this unique form is possibly an Echinoderm modified by parasitism, or that it ought to be referred to a new but allied division.

Pelagic Micro-organisms of Fresh-water Lakes.†—Of late years several authors have described the numerous kinds of vegetable and animal organisms living in the pelagic region of lakes. M. H. Forel corroborates Asper's statement ‡ as to the predominance of certain forms on different days, in the Lake of Geneva. "The rich development of micro-organisms leads to a better understanding of the cycle of life in the pelagic region of the lake."

* Journ. de l'Anat. et de la Physiol., xxiii. (1887) pp. 1–17 (2 pls.).
† Arch. Sci. Phys. et Nat., xvii. (1887) pp. 60–2.
‡ See this Journal, 1887, p. 53.

The water contains in solution 0·01 gr. of organic matter per litre. This material is fixed by vegetable organisms, e. g. bacteria, algæ, desmids, diatoms, oscillaria, &c. The "aquatic dust" in suspension in the water is absorbed by Protozoa. It is the first stage in the organization of nutritive material. Larger animals, such as rotifers and Entomostraca, feed on these plants and animals. Insectivorous fishes feed on these, and carnivorous fishes prey on the last: whilst finally these are eaten by birds and man. The carcases and ejecta of all these forms serve to keep the quantity of organic material constant.

Microscopic Fauna of High Alpine Lakes.*—Dr. O. E. Imhof has investigated the fauna of various Alpine lakes at altitudes of from 600–2780 metres above the sea; after a reference to what has been done by previous observers he gives the results of his own studies. The great majority of lakes over 2000 metres harbour a pelagic fauna which is very rich in individuals; in some a *Daphnia* was particularly plentiful, and in others *Diaptomus alpinus;* up to 1796 metres (the Silsersee) there were 7–16 species in one lake; the higher the elevation the smaller the number of species; *Daphnia*, *Cyclops*, and *Diaptomus* were the most widely distributed genera; *Bosmina* was found at 1908 m. (Cavloccio); *Leptodora hyalina* was nearly always present up to 1075 m. *Anuræa longispina* was the most generally distributed rotifer, and was found as high as 2640 m. Among the Protozoa *Ceratium hirudinella* was widely and generally found as far as 1993 m. *Peridinium* extends to 2222 m. The Copepod *Heterocope robusta* was found in three lakes in the Upper Engadine.

Mollusca.

Growth of the Molluscan Shell.†—According to Réaumur (1709) the growth of the Molluscan shell was due to the mechanical deposition of a secretion. In spite of the objections urged by Méry (1710) and Hérissant (1766), who advocated an internal organic growth by intussusception, Réaumur's theory has been virtually accepted till within the last few years. A vigorous opposition by Nathusius-Königsborn in 1878, followed up by Tullberg in 1882, and Ehrenbaum in 1884, has done much to elucidate the process. According to Tullberg one portion of the shell grows by apposition, another by the modification of the outer zone of epithelial cells, while Nathusius-Königsborn maintained that the growth of the shell, though strictly internal, was independent of any cellular element. F. Müller (1885), on the other hand, was led to conclude that the shell does *not* grow independently of the cells, while his results were equally conclusive against the possibility of growth by apposition of elements secreted from the mantle. A brief summary of some of the more detailed results of the last two observers is given at the reference noted below.

Nervous System in Tenioglossate Prosobranchs.‡—M. E. L. Bouvier describes certain modifications of the typical strepsineurous arrangement in Prosobranchs, which lead on to a zygoneurous condition. Some of the Melaniidæ and Cerithiidæ have a commissure passing directly from the subintestinal ganglion of the visceral loop to the pallial (pleural) ganglion, on the right side. Other members of the group have this connection less perfect. The union between the supra-intestinal and pleural ganglion of the left side is much rarer, but M. Bouvier finds it in *Ampullaria*, *Natica*,

* Zool. Anzeig., x. (1887) pp. 13–17, 33–42.
† Naturforscher, xx. (1887) pp. 137–8.
‡ Comptes Rendus, civ. (1886) pp. 447–8. See also this Journal, 1886, p. 584.

Cypræa and others. A resemblance also holds between the Aspidobranchs (*Haliotis*) and the other prosobranchs in the arrangement of the stomatogastric nerve.

In regard to the pedal nerves, too, transverse commissures, like those of *Haliotis*, are found in *Paludina*, though few in number; but in *Cyclophorus* there may be as many as 15 in number: where also a zygoneurous condition is present. Hence this genus is more nearly allied to *Paludina* than to *Cyclostoma*.

Anatomy of Patella vulgata.*—Mr. R. J. Harvey Gibson has published the first, or anatomical, part of a projected monograph on the common limpet, in which he gives detailed accounts of the various organs, incorporating the results of the investigations of his predecessors (which he has, when possible, examined for himself), with those to which his own studies have led him.

After describing the external form, the little known and complicated alimentary canal is dealt with; on the palate and on the floor of the pharyngeal chamber there are two plates which protect the subjacent tissues from injury from the teeth of the radula; the intestine lies in apparently endless coils, the dissection of which is attended with great difficulty, not only because of the extreme tenderness of the intestinal walls, but on account also of the intricate way in which the coils are intertwined, and the intimate connection that there is between them and the liver, right kidney, and connective tissue supporting these organs; in only one out of twenty limpets was the dissection complete, and the alimentary canal was then found to measure more than fourteen inches in length, the whole antero-posterior diameter of the animal itself being only $2\frac{1}{4}$ inches.

The circulatory system consists of a branchial vein with veinlets, a heart and two efferent vessels; the branchial vein cannot be distinguished from a large lacuna, having no special lining of epithelium and its walls being composed of connective tissue. The heart consists of a large, very thin-walled auricle, and a ventricle which is practically a sponge of muscle-fibres. The functional gills are, morphologically, processes of the mantle, which, also, has a respiratory function; the mass of the latter consists of connective tissue and muscle, with large and small lacunar spaces, and the structure of the gills is essentially similar. The author agrees to Lankester's statement that the renal sac is practically a series of blood-vessels covered by renal epithelium; this epithelium is arranged in several layers; the lower cells are rounded or polygonal, and present a homogeneous protoplasm crowded with granules of a light green or brownish tinge; the upper cells are much larger, and contain a number of vacuoles, and are, further, ciliated; the right is much larger than the left nephridium, and there is possibly some difference in the chemical characters of their secretions.

The integument consists of two or three layers, according to position, a layer of light pigment-cells being added to the layer of dark pigment-cells and the layer of connective tissue in the region of the nephridia.

Nothing in the way of glands, suckers, or spicules could be made out in the foot. The nervous system is exceedingly complicated, there being no less than eight pairs of ganglia; of these the cerebral, visceral, and pedal are alone of primary importance; some of Brandt's statements as to the origin of the visceral and recurrent nerves are corrected; the account given of the eyes agrees in nearly all particulars with that of Fraisse regarding *Patella cærulea*. The two tentacles are the special organs of touch.

* Trans. Roy. Soc. Edinburgh, xxxii. (n.d.), pp. 601–38 (5 pls.).

The sexes are separate, the gonads single, and their ripe products are poured into the cavity of the right kidney, whence they escape by the right renal papilla; the generative duct described by Cuvier has, then, no existence; Dall is incorrect in denying the presence in *P. vulgata* of the "capitipedal orifices," while Spengel was wrong in regarding them as orifices, for they are the vestigia of the lost true gills. Mr. Harvey Gibson's experience does not tally with that of MM. Robin and Lebert, who failed to find the gonads in more than half the specimens they examined, for in more than one hundred specimens collected at various dates he always found the gonads, though they were sometimes small.

Concretionary Gland of Cyclostoma elegans.*—M. P. Garnault refers to the "glande à concrétions," which is found below the organs of Bojanus in *Cyclostoma elegans*. Barfurth found that the concretions were of uric acid, and, as such were wanting from the organ of Bojanus, he concluded that the gland in question was the functional kidney.

M. Garnault finds that the gland consists of numerous tubes collected into tufts, and connected to the digestive tract by loose connective tissue, while they are surrounded by a very rich vascular plexus, which can be easily injected. In the adult, at any rate, the gland is without any excretory canal. The concretions, when carefully observed, are found to be absorbed. A prodigious quantity of bacilli are to be found filling up completely the cavities of the tubes, and their presence is undoubtedly normal. The author thinks that these bacilli contribute to the deposition and the absorption of the uric acid, but he has not yet made the experiments proper for determining this question; notwithstanding the absence of uric acid from the organs of Bojanus he believes that it is nevertheless the true kidney, and suggests that the waste nitrogenous products may be excreted under some other chemical form.

Osphradium of Crepidula.†—Dr. H. L. Osborn describes the osphradium of *Crepidula* which appears to have hitherto escaped notice. In *C. fornicata* it is represented by eighteen or twenty papillæ placed in a longitudinal row on a low ridge parallel with the gill; each papilla has a globular expanded head supported on a short narrow peduncle. The longitudinal axis of the organ is traversed by a nerve-trunk which sends a branch into each papilla; the free ends of the columnar epithelial cells appear to be ciliated, and those doubtless are sensory in function which are placed at the summit of the papilla, where there is no distinct basement membrane, as there is on the sides.

A hitherto unnoticed area of peculiarly modified epithelium runs along the ridge from which the gill-filaments arise; this consists of very tall cells, altogether unlike any other that are found on the mantle, and they are so set as to form what appears to be a specialized organ.

Terrestrial Air-breathing Molluscs of the United States.‡—Mr. W. G. Binney has published a second supplement to the fifth volume of his 'Terrestrial Air-breathing Molluscs of the United States and adjacent territories.' It contains lists of the locally introduced species, the universally distributed species, and the Central and Pacific province species. The most variable species found in North America appears to be *Patula strigosa*, the geographical range of which is very great; the various forms are considered under the three heads of (α) shell transversely ribbed, (β) shell smooth or with rough striæ, (γ) shell longitudinally ribbed;

* Comptes Rendus, civ. (1887) pp. 708–9.
† Zool. Anzeig., x. (1887) pp. 118–9.
‡ Bull. Mus. Comp. Zool., xiii. (1886) pp. 23–48 (3 pls.).

thirteen varieties are considered, and some of their characters noted. *Triodopsis Sanburni*, *T. Harfordiana*, and *T. Hemphilli*, are new species. In dealing with the species of the Pacific province, those from the extreme northern region are not included, as they more properly belong to the fauna of Asia.

Molluscoida.

α. Tunicata.

Colonial Vascular System of Tunicata.*—M. F. Lahille denies that the colonial Tunicata generally have a common vascular system, and asserted that this only is rarely present. The genera that have a colonial plexus are those in which there is a basal stolonial blastogenesis, such as *Perophora*, *Clavulina*, some of the Cionidæ, and some of their allies. What, in other Tunicates, has been taken for such a plexus, has really a very different significance; in the Diplosomidæ, Didemnidæ, and Leptoclinidæ, there are muscular cones, which have a fixing function, and as they may be very long and underlie the substance of the tunic, they have been mistaken by M. Giard for vessels. In the Aplididæ there is not even an appearance of a colonial plexus; in the Botryllidæ the anastomoses of the vascular appendages only appear after blastogenesis. As most of the Synascidians are merely aggregations, they are only separated from the Monascidians by their blastogenetic origin, and as the entirely blastogenetic origin of the cormus and the general presence of a colonial vascular plexus has been shown not to obtain, M. Lahille thinks that there is no longer any reason for separating these two orders of Tunicates.

New Organ of Respiration in Tunicata.†—Prof. W. A. Herdman gives an account of the structure and distribution of blood-cavities in the test of various Tunicates; the disposition and anatomical characters in the different regions and layers of the test lead him to think that in most Ascidians these tubes exercise more or less perfectly a respiratory function; further evidence is afforded by the relation which exists in many groups between this system and the branchial sac or chief organ of respiration. When the sac is large and highly developed, the vessels in the test are few and small, but when the branchial sac is small, simple, and apparently inefficient, the vessels in the test are numerous, of large size, and disposed in such a manner as to suggest at once that they are concerned in the aeration of the blood.

'Challenger' Tunicata.‡—Prof. W. A. Herdman reports on the compound Ascidians collected by the 'Challenger.' This, one of the most difficult of all groups of animals, was represented by 25 genera and 102 species; ten of the former and 88 of the latter are regarded as new. The forms are chiefly littoral in habitat, only seven extending to a depth of 1000 fathoms; one of the most remarkable is *Phenyngodictyon mirabile*, which was taken from a depth of 1600 fathoms. The compound Ascidians are regarded by the author as having had a polyphyletic origin among the simple forms.

β. Polyzoa.

Critical Notes on Polyzoa.§—The Rev. T. Hincks commences by discussing the characters of the family Adeoneæ, with especial reference to the "somewhat heterogeneous company" included in it by the late Mr.

* Comptes Rendus, civ. (1887) pp. 239–42.
† Proc. Lit. and Philos. Soc. Liverpool, xxxix. (1885) pp. 39–46 (1 pl.).
‡ Reports of the Voyage of H.M.S. 'Challenger,' xxxviii. (1886) pp. 432 (49 pls.).
§ Ann. and Mag. Nat. Hist., xix. (1887) pp. 150–64.

Busk. He says that the pores in one section of the group have a totally distinct morphological significance, and have possibly also a different function from that of the other. He proposes to refer to the Microporellidæ that division of the Adeonidæ which exhibits the zoœcial structure characteristic of the genus *Adeona*, and this is the view of Prof. Smitt. With regard to the question of dividing the genus *Adeona*, it is remarked that there is no element of structure among the Polyzoa so liable to adaptive modifications as the so-called radical appendages, and Mr. Hincks thinks that the species may well be ranged under the two heads of (1) w th a flexible stem and (commonly) fenestrate zoarium, and (2) without a flexible stem.

Treating of the Membraniporidæ the author discusses his species *Membranipora radicifera*, and has some notes on the genera. The family characters of the Microporidæ are defined, as are also those of the Steganoporellidæ; this last contains at present three genera, the third of which—*Thalamoporella*—is new.

'Challenger' Polyzoa.*—The late Mr. G. Busk's second report on the Polyzoa of the 'Challenger' treats of the Cyclostomata, Ctenostomata, and Pedicellinea; forty-six species are enumerated, of which thirteen appear to be new. The Pedicellinea are represented by *Ascopodaria fruticosa* and *A. discreta;* Mr. Busk gives his reasons for preferring his generic name to *Barentsia* or *Pedicellinopsis.*

Key to the Fresh-water Polyzoa.†—A useful analytical key to the known species of fresh-water Polyzoa, with figures, is published in the journal noted at foot. It is based on Dr. J. Jullien's 'Monographie des Bryozoaires d'eau douce.'

Fresh-water Bryozoa.‡—Dr. W. Reinhard repels the accusation of Herr Ostroumoff that in his account of the metamorphosis of *Alcyonella fungosa* he only describes pathological processes. He confirmed the observations of Nitsche, and as to what he has added to them with regard to a special appendage there is no question of pathological change. Herr A. Ostroumoff has a reply to these criticisms.§

Arthropoda.

Classification of the Arthropoda.‖—Prof. E. Ray Lankester publishes a further answer to Prof. Claus, in which he repeats his statement that what Prof. Claus announced as novelties had been formulated by him five years previously, and he discusses the explanations given by Prof. Claus.

Digestive Tract of Arthropoda, and particularly of Insects.¶—Prof. A. Schneider has discovered that the tunica propria which underlies the endodermal cells of the midgut of Arthropods, consists of chitin. Where the foregut of insects is united with the midgut there is a remarkable, and as yet unnoticed, arrangement of the longitudinal fibres; they arise behind the middle of the foregut and become separated from the intestine, a part only being inserted behind the commencement of the midgut; this must cause an invagination of the foregut, and so lead to the formation of a proboscis which leads to various structures; it may be simple or lobed, or beset with setæ and teeth, and so on. The proboscis is of some size in the larvæ and

* Reports of the Voyage of H.M.S. 'Challenger,' l. (1886) 47 pp. and 10 pls.
† Journ. Trenton (N.J.) Nat. Hist. Soc., 1887, pp. 59–67 (1 pl.).
‡ Zool. Anzeig., x. (1887) pp. 19–20. § Tom. cit., pp. 168–9.
‖ Ann. and Mag. Nat. Hist., xix. (1887) pp. 225–7.
¶ Zool. Anzeig., x. (1887) pp. 139–40.

imagines of Diptera, Orthoptera, Forficulidæ and *Lepisma*; it is smaller in the Coleoptera and Neuroptera, and is wanting in other insects. At the hinder end of the foregut of many insects the cuticle forms a fold which extends as far as the anus in the form of a tube. Professor Schneider proposes to call it the infundibulum. It is generally present in all the forms that have a proboscis, but is wanting in the Dytiscidæ and Carabidæ among the Coleoptera, and is found in all larvæ except those of Lepidoptera. All the insects and larvæ that possess it eat hard and even indigestible foods, while the others take fluid nutriment. When it is present in the larva it may persist in the imago even when, as in the Diptera, the mouth-organs and the mode of life are altered. Where it is found, the materials taken into the intestine do not touch the surface of the mid- or hindgut. The enteric respiration which obtains in many insects has no effect on the contents of the intestine, as the infundibulum is elastic and firmly incloses the contents. This structure was first seen by Wagner in the viviparous larvæ of the *Cecidomyiæ*, where alone it has till now been noticed.

Comparative Morphology of the Brain in Insects and Crustacea.*—M. H. Viallanes gives the names *protocerebrum*, *deuto-*, and *trito-cerebrum* to the three lobes of the supra-œsophageal ganglion of the decapod Crustacea. He compares each lobe, which consists of two lateral halves connected across the middle line, to a ganglion of the ventral chain; although the trito-cerebrum appears not to be so connected. But from an examination of these parts in some of the Orthoptera, he finds a commissure between these lobes passing below the œsophagus. The protocerebrum innervates the eyes in both Crustacea and Insects; the deutocerebrum innervates the antennæ of insects, and the antennules of Crustacea, and the nerve rises in two roots; in both classes a nerve passes from this lobe to the integument; the tritocerebrum sends nerves to the second antennæ in Crustacea, and to the labrum in Insects: hence he draws an homology between these structures; and concludes that there are three prebuccal segments in both classes.

α. Insecta.

Vision of Insects.†—M. A. Forel gives an account of past and recent experiments on the vision of insects, and sums up the conclusions as follows:—

(1) Insects direct themselves, in flight almost wholly, and on the ground partially by means of their facetted eyes. The antennæ and buccal sensory organs cannot serve for directing flight. Their extirpation makes no difference.

(2) J. Müller's mosaic theory is alone true. The retinulæ of the compound eyes do not each receive an image, but each receives a simple ray more or less distinct in origin from that of its neighbours. Gottsche's theory is false. (Müller, Grenacher, Exner.)

(3) The greater the number of facets, the more elongated the crystalline cones, the more distinct and the longer the vision. (Müller and Exner.)

(4) Insects can see particularly well the movements of bodies, and better during flight than when at rest, the image being displaced in relation to the eye (Exner). This perception of the mobility of objects diminishes as the distance increases.

(5) Contour and form are only indistinctly appreciated, and the more indistinctly the fewer the facets, the shorter the crystallines, the farther

* Comptes Rendus, civ. (1887) pp. 444–7.
† Rec. Zool. Suisse, iv. (1886) pp. 1–50 (1 pl.).

and smaller the object. Insects with big eyes with several thousand facets can see with tolerable distinctness.

(6) In flight, insects can by means of their compound eyes appreciate with accuracy the direction and distance (not too great) of objects. When at rest they can also estimate the distance of fixed objects.

(7) Certain insects (bees and humble-bees) can clearly distinguish colours, and that better than form. In others (wasps) the perception of colour is very rudimentary. Ants perceive the ultra-violet rays (Lubbock).

(8) The ocelli seem to furnish only very incomplete vision, and to be simply accessory in the insects which possess also compound eyes.

Function of Antennæ.*—Prof. V. Graber communicates the results of further experiments on the function of antennæ. These corroborate his previous conclusions, that strong smells affect the delicate portions of the skin, and that finer smells useful in nutrition are in some cases certainly and specially appreciated by the antennæ. The author answers some apparent misunderstandings of Plateau, and proceeds to subject the experiments of his colleague to a searching criticism, showing that Plateau's *proof* of the olfactory function of the antennæ in the cockroach is false and inadequate, though the conclusion is indeed correct. Graber chronicles his own experiments, showing that cockroaches without feelers can hardly or in no wise smell, and that the feelers really and specially act as smelling organs. He does not, however, affirm this as a general proposition, since some insects appear to have no sense of smell whatever, while others can smell their food even when robbed of their antennæ. Further details are promised in a work in preparation.

Holopneusty in Beetles.†—Dr. E. Haase communicates a note on the import of the distribution of stigmata in larval beetles. Fr. Brauer (1869) expressed the opinion that lank active larvæ were the primary forms, and the sluggish grubs secondary adaptations. Lubbock confirmed this, and Palmén supported the distinction by reference to the morphology of the tracheal system. In addition to three previously reported (Elmis and two Lycidæ), Haase notes four cases of holopneustic larval forms (Telephorus, Phengodes, Lampyris, and various Drilidæ). Insects without quiescent pupa stages, with so-called incomplete metamorphosis, may be ranked along with the above beetles as forms with persistent distribution of stigmata, as "menotreme,"—in contrast to "metatreme" insects in which the holopneusty of the imagines has been re-acquired in post-embryonic development. According to the primary or secondary development of the mouth-parts, Fr. Brauer similarly divided insects into "Meno-" and "Metagnatha." With the exception of *Elmis* the holopneustic larval forms mentioned belong to the Malacodermata division of beetles which in many ways approach near to the primitive Coleopteran form. The individual development is thus also primitive; the larvæ are comparatively like the imagines, being modified only by a few secondary influences. Their metamorphosis is thus in a certain way related to the anamorphosis of the Hemimetabola (*Homomorpha*). "The quiescent pupa-stage which, though ever so imperfectly, they pass through, is to be referred to and explained as (in Brauer's words) 'abbreviated stages of growth,' as the secondary, almost synchronous compression of several genealogically successive and distinctly separate steps of developmental progress."

Labium of the Coleopterous genus Stenus.‡—Herr F. Meinert explains the peculiarities in the structure of the mouth-organs of *Stenus* as

* Biol. Centralbl., vii. (1887) pp. 13–9. † Ibid., pp. 53–4.
‡ Zool. Anzeig. (1887) pp. 136–9.

being due to the fact that the primary or sternal piece of the labium and the connective membrane which unites it with the mentum are extraordinarily elongated; in consequence of this the primary piece can be protruded and withdrawn through a considerable space; the paraglossæ are wanting. The labial palps are remarkable for their club-shaped form, but this is not quite so remarkable, as an examination of the genus *Megalops* would show. Figures in illustration are promised in a more extensive memoir which will shortly appear.

Prothoracic Appendages of Lepidoptera.*—M. N. Cholodkovsky, referring to the previous communication made by Dr. Haase, allows that the presence of prothoracic appendages has been noted by previous writers, but he traverses the opinion of his critic that the parts in question are secondary accessory structures. The justice of this criticism, and of others like it, is difficult to determine, but the following facts seem to speak against Dr. Haase; structures which are morphologically of the same value appear in different forms at very different stages in development, and the late appearance of the appendage is not *pro tanto* an argument against their primary nature; again in the development of the Squillidæ we find pairs of extremities well developed in the Protozoea-stage, which atrophy in the zoea, and again appear after metamorphosis. In position the prothoracic appendages agree better with rudiments of wings than with tegulæ, and in structure they are not hard solid chitinous plates, as are the tegulæ, but soft vesicles filled with blood and tracheal branches.

Morphology of Malpighian Tubes in Lepidoptera.†—M. N. Cholodkovsky has studied the morphology of the urinary system of Lepidoptera which turns out to be less uniform than is usually supposed.

(*a*) In *Tineola biselliella*, for instance, there are only two long simple tubes, while in the Lepidoptera generally there are always six. In the caterpillars of *Tineola*, however, there are six as in other Lepidopteran caterpillars. On the second day of chrysalid life the six tubes exhibit symptoms of degeneration. The terminal tubes gradually disappear by histolysis, the basilar trunk increases, and eventually gives rise to the simple urinary apparatus of the adult. The author notes the probable connection of this series of changes with the abundant nutrition of the caterpillar, the fasting life of the pupa, and the advantage of lightness in the adult insect.

(*b*) In *Galleria melonella* the urinary system is represented by two richly and irregularly ramified trees; neither basilar trunk nor terminal tubes nor bifurcation of a trunk into branches. A very short lateral prolongation of the intestine is regarded as homologous with the basilar trunk. In the caterpillar the usual six vessels are present, and these disappear as above, being replaced by a secondary arborescent growth in the chrysalis. The caterpillar devours enormous quantities of fatty substance. It is probable that this reserve store is utilized in the chrysalis phase, and the great development of the urinary vessels would permit of the rapid elimination of large quantities of oxidized material.

(*c*) In the other Lepidoptera the variations are insignificant: a brief summary of their peculiarities in the different families is communicated.

(*d*) The embryological studies of Hatschek and Tichomirow have shown that the Lepidopteran embryo has only two basilar trunks arising as diverticula from the rectum. In *Tineola biselliella* these are much

* Zool. Anzeig., x. (1887) pp. 102–3.
† Arch. de Biol., vi. (1887) pp. 497–514 (1 pl.).

elongated; in *Galleria melonella* they are associated with an arborescent growth. In most Lepidoptera three terminal tubes are formed on each side. Two first appear and one bifurcates. The author notes the fundamental importance of the basilar trunk, the structure of the system in the more primitive Tracheata, discusses the theory of atavism, and finally distinguishes, as above, the three types of urinary system in Lepidoptera: (1) *normal*, with six vessels joining the intestine by two basilar trunks (majority); (2) *atavistic* or *embryonic*, with two simple vessels (*Tineola biselliella*, *Tinea pellionella*, *Blabophanes rusticella*); and (3) abnormal (*Galleria melonella*) with two ramified trees.

Cause and Extent of Colour-relation between Lepidopterous Pupæ and surrounding surfaces.*—Mr. E. B. Poulton has made a series of experiments with lepidopterous pupæ for the purpose of testing the correctness of his idea that the relation between the colour of lepidopterous pupæ and their surroundings was a physiological one, and that the reflected light would be found to act on the larva at some time before pupation, and not on the pupa itself; it also seemed to him to be probable that the sensitive area might be defined by experiment.

Experiments made on *Vanessa Io*, in which six mature larvæ were placed in a glass cylinder surrounded by yellowish-green tissue-paper, resulted in five changing into the rarer yellowish-green form of pupa. Over 700 specimens of *V. urticæ* were experimented on; and observations were made on the result of different colours, the effects of mutual proximity, the effects of illumination, and the times during which the larvæ are sensitive; experiments on various parts of the body showed that the whole skin area is susceptible. Further observations were made on *V. Atalanta*, *Papilio Machaon*, *Pieris brassicæ* and *P. rapæ*, *Ephyra pendularia*, and *Saturnia carpini;* the study of the last seems to show that the influence of the surroundings can only be explained by the supposition of a complicated physiological and apparently nervous circuit.

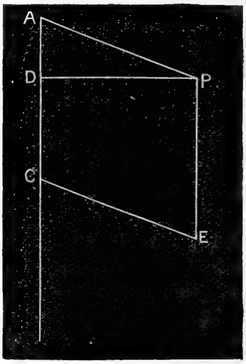
Lepidopterous Larvæ, Pupæ, &c.†—Mr. E. B. Poulton after detailing his observations on the larvæ of *Smerinthus tiliæ* and *S. ocellatus* and the red spots in their larvæ, as also on the markings of the adult larva of *Acherontia atropos*, describes the markings aiding in the terrifying aspects produced by the attitude of the larva of *Chærocampa Elpenor*. The terrifying attitude of the larva of *Dicranura vinula* produces an exaggerated caricature of a sort of generalized vertebrate appearance, e. g. a serpent, such as would alarm small birds, and in this larva a fluid consisting of formic acid is ejected from a gland, the duct of which opens below the head, and so arranged that when the larva is disturbed, the fluid is directed directly forwards. In *D. furcula* there is a green eversible gland occupying the same position as this poison-gland, and the author considers this to be a more primitive arrangement. The larva of *Orgyia pudibunda* has an eversible gland situated in the median dorsal line of the seventh abdominal segment, and eversion takes place when the larva rolls up. The larva of *Hemithea thymiaria*, in its normal attitude, has a very perfect resemblance to a twig, owing to its head being notched, and to the presence of dorsal tubercles. The early life of the larva of *Acryonycta leporina* is passed on the lower side of the leaf of the alder or beech. It is concealed by its long white hairs, but later on, when about to burrow in the bark, the hairs become darker and thus render it less conspicuous.

The apparatus by means of which imagines escape from the cocoon is

* Proc. Roy. Soc., xlii. (1887) pp. 94–108.
† Trans. Entomol. Soc. Lond., 1886, pp. 137–79 (1 fig.).

noted. The cocoons of the Chloephoridæ have a sharp ridge at the anterior extremity; this ridge is formed by two closely fitting edges, forming a valve, this can be easily opened from within, to allow the imago to escape, but will not yield to any ordinary pressure from without. The larva of *Paniscus cephalotus*, parasitic on the larvæ of *Dicranura vinula*, is also described, as well as its development. The author deals with the distribution of derived plant pigments. These are found to be differently distributed in various larvæ. In some *Noctuæ* green pigments are dissolved in the blood; in the green Sphingidæ, the pigment passes from the blood into the cells of the hypodermis. Before pupation the pigments are withdrawn and dissolved in the pupal blood. Various tables are given bearing on the loss of weight in the pupa immediately after throwing off the larval skin. This loss of weight is chiefly due to evaporation from the surface of the body, but also to the active muscular effort of pupation, entailing loss of water, and carbonic acid through the tracheal system. On the other hand, there must be a gain of weight due to absorption of the oxygen, which is stored up as the oxidized products of nitrogenous metabolism, which fill the digestive tract of the pupa and imago within it.

FIG. 95.



Geometrical Construction of the Cell of the Honey-bee.*—Prof. H. Hennessey gives a figure and the method by means of which the lozenges composing the cell can be obtained.

On a straight line take a part A D, and lay off D C = 2 A D. From D erect a perpendicular, and with a radius A C = 3 A D cut off DP: then A C and A P are sides of the lozenge A C E P. From this, the remaining two lozenges, and also the six trapeziums can be obtained. The triangular pyramid which terminates the bee's cell may be inscribed in a sphere whose diameter is three times the size of one of the edges of the pyramid. The diameter of this sphere can be found by a mathematical formula which he gives.

Anatomy and Histology of Culex nemorosus.†—Herr W. Raschke states that in general habit the larva of *Culex nemorosus* resembles the aquatic larva of the Nemocera; the cylindrical body consists of twelve somites, the first three of which are fused to the thorax. The strong chitinous tubes which project from the penultimate somite are very striking; a valvular apparatus not only enables the animal to remain at the surface of the water, but also serves to close the tracheal endings in the siphon; these have also a peculiar constriction, the mechanism of which is connected with the valves and serves as a second closing-organ. Respiration is also effected by anal gill-plates, and by an exchange of gases through the integument; the rectum is provided with means for containing a large number of tracheal branches. In addition to the two pairs of eyes, the larva has various sensory hairs, which are found not only on the antennæ and epipharynx, but are also specially arranged over the whole body.

Males of Lecanium hesperidum, and Parthenogenesis.‡—M. R. Moniez has found the males of *L. hesperidum* in a large number of females examined between September and February: each male was in a separate ovarian

* Proc. Roy. Soc., xli. (1886) pp. 442–3 (1 fig.). See this Journal, 1886, p. 234.
† Zool. Anzeig., x. (1887) pp. 18–9. ‡ Comptes Rendus, civ. (1886) pp. 448–51.

cæcum: and these cæca were mixed up with those containing larvæ of females. The development of the male larva was traced to the perfect state; when it is characterized by its small size, thin integument, absence of eyes and of wings, and by the development of spermatozoa before the appearance of the appendages.

The development of the spermatozoa differs considerably from that in neighbouring forms.

Although doubtful on the point, M. Moniez considers it probable that impregnation takes place while the male is still within the female: and he shows how, by a farther reduction of the male, till it is represented by only sexual elements, a false hermaphroditism may be brought about. Thus, many cases of parthenogenesis and pædogenesis may really be gamogenetic, since the pseudova may be ordinary ova, fertilized before being laid, by means of the spermatozoa, which are all that represents the male.

Galls on the Leaf of the Vine.*—Herr T. von Ohrdruf states that on the leaves of vines, cultivated in Europe, three kinds of galls can be distinguished:—(1) The Erineum of *Phytontus Vitis*, (2) the Phylloxera gall, and (3) the gall of *Cecidomyia œnophila*.

The Erineum cannot be confounded with the other two; but in order to distinguish the two latter, the following characters are given. The galls of *Cecidomyia* project from both surfaces of the leaf, are circular in form, and their colour varies from greenish yellow to deep red. They are spread over the leaf without any order, and their number is sometimes as many as from thirty to sixty. The Phylloxera galls are of the same shape, the difference, however, is that these galls on the upper surface of the leaf have a roundish or fissure-like opening, bordered by hairs and projections, while on the under surface of the leaf there is a large projection with a contraction at its base. The gall of *Cecidomyia* has no opening on the upper surface, is small, and lenticular in form.

β. Myriopoda.

Ancestors of Insects.†—Dr. E. Haase thinks that *Scolopendrella* stands nearest to the primitive insect or Archentomon; it is distinguished by its multiarticulate antennæ; three pairs of jaws, of which the last is poorly developed, its twelve pairs of five-jointed ambulatory legs, and a pair of long caudal appendages in which is placed a spinning-gland. It is also remarkable for its abdominal processes; these appear to correspond morphologically to the calcaria of most Tracheata, and are homologous with the appendages on the last two pairs of legs in *Machilis;* from the second to the eleventh segment there are clefts leading to pouch-like glands, which may be distinguished as the abdominal pouches; these obtain also in most of the Thysanura, in *Peripatus*, and some Myriopoda. The evidence afforded by larvæ of insects is also discussed, and some of the difficulties explained by supposing that separate developmental phases which appeared successively are compressed and intercalated with one another in the course of ontogenetic development. The wings may be regarded as folds of the dorsal plate.

Relationships of Myriopods.‡—Starting from *Scolopendrella*, Dr. E. Haase seeks to derive from a related type the orders of Myriopods and of apterygota or lowest insects. He lays emphasis on the morphological

* Entom. Nachr., 1886, pp. 129–35. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 219.

† SB. und Abhandl. Isis in Dresden, 1886 (1887) pp. 85–91.

‡ Biol. Centralbl., vi. (1887) pp. 759–60. (Ber. Versammlg. Naturf. u. Aerzte Berlin, 1886.)

importance of the ventral appendages—“Hüftspornen” and “Hüftdrüsen.” Terminal spurs are represented in *Scolopendrella* and many Chilopoda by simple immovable epithelial structures on most of the appendages, though sometimes peculiarly displaced. The well-developed appendages, corresponding to “hip-spurs,” and usually designated parapodia, as in *Machilis*, serve for location, while the true extremities are reduced. “Hip-glands,” demonstrated in *Peripatus*, occur also in *Scolopendrella*, *Machilis*, *Campodea*, &c., in *Craspedosoma* and *Lysiopedalium* among Diplopoda, in *Lithobius* on the last four (rarely five) segments, and finally in *Chilepimorpha*, in which the hips are reduced, on the pleural plates of the last limb-bearing segment. They secrete a gummy secretion of use in attachment to smooth surfaces, for fastening the spermatophores in *Geophilus*, &c. The Symphylid Myriopods are to be regarded as primitive. The epimorphous *Campodea* and *Japyx* are in close relationship to the hemimetabolic (anamorphous) Hexapods, and from these certain beetle families (Lampyridæ, Phengodes) afford transition forms to the holometabolic (Metamorpha) insects.

Mechanism of Respiration in Myriopoda.*—M. J. Chalande describes a series of experiments on various species of Myriopods, undertaken in order to ascertain whether respiration in these animals resembled, in its mechanism, that in insects.

By means of a simple apparatus, which is described, he was able to examine the animals, while alive, under the Microscope, in order to determine whether there were any external movements of inspiration and expiration, movements of contraction either transverse or longitudinal, or of the rings upon one another. The result is negative. Another series of experiments, in which the animals were partially asphyxiated, either by water or carbonic acid, and were then restored by a current of air, was made in order to ascertain whether the stigmata could be completely closed. The answer to this was also a negative. The experiments are described in detail, and the following genera were experimented upon, in some cases two or more species of the genus were used:—*Geophilus*, *Schendyla*, *Himantarium*, *Scolopendra*, *Cryptops*, *Lithobius*, amongst the Chilopoda; and *Glomeris*, *Iulus*, *Blaniulus*, *Strongylosoma*, *Polydesmus*, amongst the Chilognatha.

The results of his experiments are given in a résumé at the end of the paper, as follows:—

“The mechanism of respiration in Myriopoda differs entirely from that in Hexapoda.

1. During repose, there are no movements of dilatation, or of contraction of the body-cavity, capable of producing or aiding inspiration and expiration.

2. Neither the stigmata nor the substigmatic membrane, execute movements in direct relation to respiration.

3. The external aperture of the stigma does not contract.

4. The stigmata play only a passive part, serving only as a means of communication between the external air and the respiratory apparatus.

5. The substigmatic pouches, where they exist, can, in certain cases, contract, under the influence of external causes.

6. The excrescences which occur upon the substigmatic membrane, can obstruct the stigmata, under the influence of external causes.

7. This obstruction is only partial. The respiratory apparatus is never completely closed.

* Bull. Soc. d'Hist. Nat. Toulouse, 1886, and Comptes Rendus, civ. (1887) pp. 126–7. See this Journal, 1886, p. 434.

8. The internal substigmatic membrane functions as a protector of the respiratory apparatus.

9. The respiratory apparatus possesses no movements of its own capable of producing influx or expulsion of air.

10. Inspiration and expiration are caused by the rhythmical movements of the dorsal vessel, and during repose this is the only cause.

11. During activity other causes aid respiration—in walking, the action of the muscles on the tracheæ, and during digestion the movement of the alimentary tract.

12. The intensity of respiration varies according to the temperature."

Stigmata of Scolopendridæ.*—Dr. E. Haase, who has been investigating the Indo-Australian Chilopoda, finds the simplest form of stigma in *Lithobius* and *Henicops;* it is distinguished by a feebly developed peritrema, by a shortish cone invested by rather short setæ, the absence of a special closing apparatus, and by tracheæ which are cylindrical and open singly; a similar form is found in the young of *Scolopendra* and *Heterostoma.* This simple form gave rise to both the cleft-like and the sieve-like stigmata. In *Cryptops* the original form is still distinctly seen, while in *Cormocephalus* the round orifice becomes more slit-like and distinctly bounded, and the simple circlets of spines before the orifice of the tracheæ lead to the stigma of the true Scolopendridæ. In the latter the stigmatic cavity divides into an outer vestibule and the true cone, while the circlet of spines is very highly developed.

The ear-shaped or branchiform stigma of *Otostigma* and *Branchiostoma* is due to the oblique form of the cone along a small part of its length; on the base of the stigmata of these forms there appear a few of those irregular darkly coloured patches, beset with small hooks, which are so common in the Chilopoda. These patches are the vestiges of the primitive base of the stigma, the clear surrounding parts being formed by the gradual flattening and widening out of the tracheæ; the external orifice of the ear-shaped stigmata is round and finely toothed at its margin, but there is no projecting ring.

The sieve-shaped stigma, e. g. that of *Heterostoma*, may be derived from this last—by supposing the floor of the stigmatic cone to become considerably widened out, the tracheæ approximated and multiplied, and the distance between the edge of the stigma and the floor of the cone gradually diminished. Although the first pair of stigmata in *Heterostoma* may be as much as 4 mm. in size, and even project beyond the plane of the body, the last shows a depression of the cone, such as is typical of *Branchiostoma.* The author has not been able to find a connecting link between the cleft-like and the ear-like stigmata. As an embryonic character of the young Scolopendridæ we have the peculiarity that each stigma is protected by a strong hook-shaped chitinous process, as much as 0·2 mm. broad; this may be regarded as a fold of the pleura. It is a secondary arrangement, adapted to the special conditions of their early life.

δ. Arachnida.

Development of Spiders.†—Herr W. Schimkewitsch has attempted to clear up some of the obscurity that has surrounded the development of spiders. He gives an historical review of the comparatively small number of important researches. No investigator has hitherto succeeded in detaching

* Zool. Anzeig., x. (1887) pp. 140–2.
† Arch. de Biol., vi. (1887) pp. 515–84 (6 pls.).

the embryo from the vitellus and making preparations of the isolated embryo. The author treated the ova of *Agelena* with 10 per cent. chromic acid for twenty-four hours, and effected the desirable result of isolation.

(*a*) *The egg envelopes.* The double membrane, demonstrated with acetic acid, consists, as Ludwig and Balbiani have shown, of two layers—an internal vitelline membrane and a superficial chorion. In *Pholcus* the little ovarian follicles are seen to be provided with a layer of epithelial cells, probably sharing in the formation of deutoplasm. The chorion is probably, however, due to the walls of the oviducts. The two envelopes are quite homogeneous. Outside the chorion is a layer of refractive corpuscles, soluble in alcohol. These are for the most part due to the epithelial cells of a special organ, the "uterus." (*b*) As to the *constitution of the ripe ovum* the author's observations have shown him (1) that the alleged division of the plasmic material into two layers does not exist, although under the vitelline envelope a peripheral accumulation of protoplasm may be readily observed; (2) that no "yolk-nucleus" is ever seen in the ripe egg, and that Schütz's interpretation is correct; (3) that the germinal vesicle does not disappear. (*c*) In regard to *segmentation*, Schimkewitsch criticizes the relative observations, and notes his own. He observed the division into four, eight, and sixteen segments, which from the exterior looked like rosettes. The yolk-globules were disposed in columns, but remained separate from one another. In sections the somewhat excentric segmentation cavity was seen. The segments were seen as pyramids internally abutting round the cavity. At the end of segmentation, a section through the centre exhibits in *Tegenaria* and *Epeira* upwards of forty pyramids. The contained protoplasmic mass then increases and becomes polynuclear; the internal extremities are resolved into yolk-spherules which fill the segmentation cavity. The protoplasmic masses and their nuclei undergo remarkable modifications. The chromatin of the nuclei mingles with the surrounding plasma. The protoplasmic masses are transformed into blastoderm cells, which are probably separated off at the peripheral extremity of the pyramids. (*d*) At this stage the egg thus exhibits two layers—the primary ectoderm of flattened cells, and the primary endoderm represented by polynuclear vitelline cells. Sometimes almost simultaneously, but often successively and in different order, the vitelline pyramids are destroyed, the primary ectoderm or blastoderm is concentrated, and *the mesoderm is formed.* Each pyramid breaks up into rounded polynuclear cells, and the destruction may occur in various directions. The author believes in an actual migration of blastoderm cells from the dorsal to the ventral pole. But after this the dorsal side of the egg reacquires a cellular mantle by the multiplication of blastoderm cells. The formation of mesoderm is signalized by the appearance, on the ventral surface of the egg, of a whitish spot (first stage), which increases gradually (second stage) and takes the form of a tubercle (or cumulus), and before this tubercle a whitish streak. The rudiment has, as Herold said, the form of a comet. Fourthly, before the cumulus primitivus a white spot appears, at first united to the cumulus by the streak above mentioned, but in the fifth stage separated from it by a depression. In regard to the first mesoderm cells, Schimkewitsch believes that in those forms where the concentration of the blastoderm precedes the formation of the mesoderm, the destruction of the vitelline pyramids occurs equally throughout the egg, and the first mesodermic cells are separated from the internal vitelline cells. In those forms where the mesoderm is formed before the concentration of the blastoderm, the destruction of pyramids takes place more energetically on the ventral surface, and the first cells are separated from two pyramids placed

close together. He regards the depression of the ectoderm during the formation of the mesoderm as a rudimentary blastopore, and the cumulus primitivus as its posterior margin

The development of the external form is described in the second chapter of the memoir, but hardly admits of brief summary. He points out *inter alia* that Balfour has erroneously described the cheliceræ in the embryo of *Agelena* as in the form of pincers. The mandibular ganglion is not visible from the exterior, and what Balfour figures as such is the basal joint of the cheliceræ.

The *organs* derived from mesoderm and endoderm are in the third chapter discussed at length. The somatic layer gives origin to (1) all the musculature of the body except that of the mesenteron if such exist, (2) the aponeurotic layer of the cephalothorax, (3) the sub-cutaneous connective tissue and the lining membrane of all the organs arising by invagination from the ectoderm, (4) the sarcolemma and neurilemma. The splanchnic layer is the origin of the membrane of the midgut, the genital organs, the pericardium, and the pulmonary veins. At the expense of the dorsal mesenteron are developed (1) the heart, (2) the lateral arteries, and (3) the mooring apparatus of the heart. The partitions give rise to the blood corpuscles. The wall of the heart is formed by two mesodermic plates which correspond to the dorsal mesenteron of Annelids. The cardiac wall of Arthropods corresponds simply to the myocardium of Vertebrates. The cavity of the heart corresponds to the segmentation cavity. The pericardiac cavity in spiders, as in Mollusca and Vertebrata, is a part of the cœlomic cavity.

The *ectoderm* gives rise to (1) the chitinous and chitinogenous layer of the integument, (2) the epithelial layer and internal tunic of all the glands, (3) the epithelium and internal lining of tracheæ and lungs, (4) the epithelium and lining of the œsophagus, rectum, stercoral pouch, and Malpighian vessels, (5) the nervous system and eyes. The central nervous system of spiders is derived from three ectodermic rudiments—(1) two thickenings of the cephalic lobe, (2) two longitudinal thickenings of the ventral wall of the embryo, and (3) a ventral median and unpaired rudiment. Its origin is exclusively ectodermic. The latter part of the memoir is occupied with a general discussion of the homologies of the nervous system of Bilateria, illustrated by diagrammatic figures.

Reported Suicide of Scorpions.*—Prof. A. G. Bourne has made a number of experiments on three species of scorpions found at Madras, with the object of determining whether or no scorpions are able to commit suicide. He finds that it is undoubtedly physically possible for a scorpion to sting itself in a vulnerable place, and when one is placed in very unpleasant circumstances it not unfrequently lashes its tail about, and causes actual penetration of the sting. But the poison of a scorpion is quite powerless to kill the same individual or another of the same or even of another species; it is, however, very rapidly fatal to a *Thelyphonus*, less rapidly so to a spider, and much less rapidly so to an insect. Two scorpions, when fighting, repeatedly sting one another with little if any effect, the stronger killing the weaker by actually pulling it to pieces with its cheliceræ. Scorpions cannot stand even a dry temperature much above 50° C., but fall into a sort of "heat coma," and soon die if the temperature be raised. The poison may be pressed out of the sting with the fingers or a pair of forceps, when it is found to be a milky white fluid with a very pungent smell, resembling that of formic acid.

* Proc. Roy. Soc., xlii. (1887) pp. 17-22.

Perineural Blood-lacuna of Scorpions.*—M. F. Houssay describes the so-called spinal artery, or perineural blood-lacuna of scorpions, and a glandular organ annexed thereto. He finds that the structure in question is really a lacuna and not a proper artery; the so-called annular artery and appendicular artery are dilatations of the lacuna of the cephalothoracic mass; an injection into the lacuna of the nerve chain is largely found on the dorsal surface of the chain, in the midst of the connective tissue without differential walls, but a little makes its way into the abdominal portion of the chain, and enters another longitudinal lacuna which lies on the ventral surface. Along the nerve chain, and not unlike the spinal artery, there is a white glandular organ, which in the fresh state is spongy; the blood forms a rich and irregular plexus in it. The close connections between it and the blood system, together with its abundant circulation, lead to the suggestion that it is a depuratory organ. Against this, however, must be set the fact that no crystals or concretions have yet been observed in it.

Structure of Pseudoscorpions.†—Herr A. Croneberg has a preliminary notice of the results of his work on the anatomy of Pseudoscorpions, based chiefly on a study of *Chernes Hahnii;* the anterior part of the rostrum consists of an almost transparent chitinous membrane, which projects in the form of an elongated oval upper lip. The edges of this lamella are fused in the anterior middle line, and are finely denticulated further back, where they are separated from one another. In the space between them there is a compressed lamella, the edges of which are also finely toothed. Posteriorly the two lamellæ pass into the short pharynx; the strongly chitinized wall of this part is produced into four wing-like ridges, which narrow the lumen. Numerous muscles serve as dilatators, while the contraction of the pharynx is effected by the elasticity of its walls.

The central mass of the nervous system is almost exactly like that of certain Acari (*Eylaïs*, *Trombidium*). The true stomach is a small enlargement, and, like the intestine, is invested by a clear small-celled epithelium; the chief mass of the viscera is formed by three large hepatic saccules, the two lateral of which break up into eight secondary lobes; the parts are connected by a vesicular connective tissue, which is especially developed in the more distal sections. The hinder half of the heart possesses a musculature arranged in numerous transverse segments, and the fissure-like orifices are in four pairs and confined to this hinder part. The gonads open by an unpaired orifice at the base of the abdomen between two transverse chitinous plates; the ovary has the form of a long unpaired tube beset on either side by a number of ovarian follicles; these appear to persist for some time after the ova have left them; the short vagina is surrounded by a close aggregation of unicellular glands, and receives also two long, much coiled, tubular glands; these correspond to the two thick packets of unicellular glands which are found in the male. The author has not been able to detect the spinning tubules reported by Menge to be present in this region; what appears to be a spinning organ lies in the cephalothorax, and consists of paired cylindrical tubules, four or five in number, which are grouped around a central canal; they open in the basal joint of the cheliceræ.

Anatomy and Classification of Phytopti.‡—Dr. A. Nalepa states that the cephalothorax of the gall-mites is unusually reduced, and besides the organs of the mouth carries only two distinctly quinquearticulate pairs

* Comptes Rendus, civ. (1887) pp. 520–2. † Zool. Anzeig., x. (1887) pp. 147–51.
‡ Anzeig. Akad. Wiss. Wien, 1886, p. 220. Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 165–6.

of legs; the mouth-organs have the form of a more or less bent rostrum. At the extremity of the abdomen, on either side of the anus, there are two semilunar retractile plates which serve either as organs of attachment or to push the animal forwards. The sexual organs are unpaired, and their apertures lie just behind the last pair of legs; in the male the aperture has the form of a fissure surrounded by swollen margins and with a supporting plate; in the female it is closed by a superior and an inferior opercular plate. The rudiments of the sexual organs appear in the larvæ as solid cylindrical cell-bodies, and then proceed so far on the course of their development that it is possible to distinguish the sexes before the last month. Twenty-four species of gall-mites have as yet been closely investigated.

New Species of Mite.*—Herr G. Horvath found in barley certain mites which occasioned an endemic skin disease among the workmen. Dr. Carpeles describes and figures the larval and mature forms under the title *Tarsonemus intectus*. He believes that the form described by Flemming as *T. uncinatus* belongs to the genus *Pygmophorus*. Skin eruptions of this kind have hitherto been observed only in Hungary, with one exception.† Herr L. Orley found larvæ both in wheat and oats causing similar eruptions, and believes that the Hungarian species probably has a much wider distribution.

Development of Phalangida.‡—Dr. H. Henking, in his investigations into the developmental history of the Phalangida, has made use of a large number of *Opilio parietinus* and of *Leiobunum parietinum*. With regard to the ovarian ovum the author confirms the results of Blanc and Sabatier, and has satisfied himself of the presence of a distinct yolk-nucleus in the young ovarian ova; the whole of it is often surrounded by a yolk-zone, and is often constricted in the middle; it disappears as soon as larger formed yolk-masses appear in the egg. The young ovarian ova have the germinal spot placed on a semilunar body consisting of granules that can be stained, and which is of unknown function; as in a number of allied forms, eggs of moderate size have a distinct yolk-membrane. The ovum, when ready to be laid, is, like that of insects, without any indications of germinal vesicle or spot. The author is of opinion that there is no emission of semen at the time when the ova are being laid, and he thinks that the structure of the receptaculum seminis confirms this view. The mode of fertilization and the causes of the disappearance of the germinal vesicle are discussed at some length. When the ova are being laid a secretion is poured out from the glandular cells which invest the inner walls of the uterus and oviduct; this gradually hardens, and surrounds the egg as it were with a shell.

Passing to the history of the development of the laid ovum, the appearance of the first nuclei is described; the earliest indications of these are plasmatic networks of not inconsiderable size which arise separately from one between the yolk-spheres; treated with Flemming's chrom-osmium-acetic acid, they are seen to be distinctly granulated. It seems, then, that in the laid ovum of the Phalangida a number of new nuclei and cells appear by free nuclear and cell-formation. The cells the author proposes to call protocytes, and the nucleus protokaryon, as Ray Lankester's name of autoplast has already been used by Krause with a different signification. When treated with Flemming's fluid each of the networks is seen to become slightly darker near its centre owing to the presence of a number of

* Math. Term. Ertesitö, iv. (1886). Cf. Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) p. 428.

† Robin, C., Traité du Microscope, 1871.

‡ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 86–175 (4 pls.).

granules of various sizes, which are quite irregularly arranged. This darkening increases, and the granules approximate to one another, and the whole appearance gradually acquires greater homogeneity; in the homogeneous figures fine achromatic bands appear, which become more and more distinct; the achromatic substance becomes spindle-shaped, and the chromatin-spheres become collected at the equator; here they form a true equatorial plate. It is important to note, in connection with the idea that the nuclear substance arises spontaneously, that distinct chromatin-spheres may appear outside but close to an already formed spindle; these are certainly remnants from the ground-mass of the chromatic substance, and they may finally become connected with some of the granular groups. The author developes in detail the evidence in favour of free cell-formation.

With regard to the position of the nuclear rudiments in the egg it is important to note that they appear throughout the yolk-masses; in the early stages there are no indications whatsoever of fission. It cannot yet be decided whether or no the appearance of several protocytes is due to a larger number of spermatozoa entering the germinal vesicle. As soon as formed, but for a short time only, the protocytes increase by indirect nuclear division; in eggs of the fourth day they are numerous. From their divisions there finally results a nucleus with distinct limits which stains intensely with carmine and hæmatoxylin, and has no further internal structure than clear vacuolar spaces. The surrounding plasma becomes much more distinct, and stains (with eosin-hæmatoxylin) red, while the nucleus becomes blue.

Before the indirect divisions of the yolk-cells in the interior of the egg cease, the future ectoderm begins to be formed. The superficial cells take a perpendicular or oblique position in relation to the periphery of the egg; these cells divide, and while one of the two new nuclei becomes again the nucleus of a yolk-cell, the outer one more and more approaches the margin of the egg, and with its surrounding plasma becomes converted into a blastoderm-cell. Dr. Henking ascribes the difference in form of the outer and inner cells to the fact that the outer ones have a proportionately smaller opportunity of obtaining nourishment, and an increased supply of oxygen. The blastoderm-cells increase by division in the direction of the periphery of the egg. As so often happens in the development of the Arthropoda the blastoderm-cells wander to one side of the egg, and there divide with especial activity. The history of this stage is entered into with great detail.

The yolk is next described; in addition to a large number of small, homogeneous, highly refractive spheres there was a considerable number of larger spheres; others, intermediate in size, were less common. The larger spheres were not ordinarily homogeneous, but contained one granular nucleiform ball or homogeneous, rounded, or semilunar masses of higher refractive power; or the spheres were finely granulated, or contained a number of not quite round homogeneous corpuscles. The spheres appear to contain a fluid which is limited externally by a membrane. In addition to the formed yolk-elements there is also unformed paraplastic substance which aids in forming the fluid in which the yolk-spheres are suspended. The author gives a most detailed account of the yolk, many of the characters of which have been already observed in the ova of other Arthropods.

Dr. Henking proceeds to discuss the changes in the cell-nucleus, its disappearance, and "free nuclear and cell-division" in the various classes of the animal kingdom. He concludes that in all classes a temporary disappearance of the germinal vesicle has been observed, and suggests that first the chromatic substance is broken up, and that afterwards the whole vesicle becomes invisible. Observations on plants as well as

animals seem to show that protocytes are first observed as spots in the egg, which become more and more distinct, or as spindle-figures, or as aggregations of chromatin granules; in the first case the eggs are either living or have been only slightly acted on by reagents; the third case is probably the typical one, and if granules should be seen arranging themselves in a spindle, the second case would fall under it. It may be laid down as a law that the free formed primitive nuclei arise from the non-nuclear protoplasm first by the appearance of chromatin spheres, which gradually crystallize out from the plasmatic magma. These spheres either arrange themselves into a regular spindle-figure or fuse directly into a protokaryon. The evidence against the spindle arising directly from the germinal vesicle appears to the author to be complete. He is also of opinion that the law, "omnis nucleus e nucleo," will be shown to be contrary to the facts of the case. This lengthy essay, in which the observations of the author are given in the utmost detail, and shown to be often confirmatory of what has been discovered in other groups, concludes with some observations on the relations of the non-nuclear ovum to fertilization, and on the disappearance of nuclei in division and in adult cells.

ε. Crustacea.

Post-embryonic Development of Telphusa fluviatilis.*—Dr. F. Mercanti finds that when the embryos of *Telphusa fluviatilis* escape from the egg they are at a somewhat advanced stage of development, for they are in the *Megalopa* condition, and have the eyes already stalked and the ambulatory appendages completely developed. The author describes the changes undergone by the limbs: the abdomen of the young is remarkable for being more like that of the adult male than of the female. The history of the development of *T. fluviatilis* has some points of resemblance with that of *Astacus fluviatilis;* but the most striking likeness is between the young *Telphusa* and adult examples of the fossil *Pseudotelphusa speciosa* from the miocene deposits of Oeningen. Dr. Mercanti's comparison of these two species leads him to adopt the theory of Prof. Capellini, that the latter is an ancestral form of the species now living.

Crustacean Parasites of Phallusia.†—M. P. Gourret has found seven parasites in the branchial cavity or cloaca of *Phallusia mammillata* and *P. mentula* from the Gulf of Marseilles; they are all crustacean. Of two known species, *Doropygus* (*Notopherophorus*) *papilio* and *D.* (*N.*) *elongatus*, there are two varieties, called respectively *massiliensis* and *maculatus*. *Pinnotheres Marioni* sp. n. differs remarkably in the two sexes. There are a few notes on *Pontonia phallusiæ*. The larvæ of a new species of *Cryptoniscus* were observed, in which the body was fusiform, the sides of the abdominal segments were prolonged into spines, one pair for each of the first two rings, and two pairs for the others; the lower antennæ carry two flagella, one of which is much reduced; the gnathopods are not forceps-like, and the dactylopodites were simple hooks. *Leucothoe spinicarpa* and *Lichomolgus forficula* complete the list.

'Challenger' Brachyura.‡—Mr. E. J. Miers confines his report on the Brachyura collected by H.M.S. 'Challenger' to the systematic aspect of the subject; the groups richest in new genera and species are the Oxyrhyncha

* Arch. Ital. Biol., viii. (1887) pp. 58–65.
† Comptes Rendus, civ. (1887) pp. 185–7.
‡ Reports of the Voyage of H.M.S. 'Challenger,' Monograph xlix. (1887) l. and 362 pp., 29 pls.

and Oxystomata; no brachyurous crab occurs in the deepest abysses of the ocean (beyond 2000 fathoms) and but very few at depths below 500 fathoms. Some of the deeper water forms were found to have a wide geographical range. Among the Pinnotheridæ the new subfamily of Hexapodinæ is instituted for those curious forms in which the fifth ambulatory legs are rudimentary or aborted. The Leucosiidæ it is proposed to divide into the Iliinæ and the Leucosiinæ.

Structure of Muscular Fibres of Hedriophthalmata.*—M. R. Koehler states that in the hedriophthalmatous Crustacea the myogenic cell is not entirely occupied by the contractile substance, and that a more or less considerable portion of the protoplasm inclosing the nuclei persists in the adult animal; the muscular bundles are remarkable in that the contractile substance occupies the central part of the cell, and the protoplasm the periphery. The muscular fibrils are grouped into small columns, which are very distinct, but their number, size, and relative disposition vary considerably. Among the Amphipoda, *Gammarus pulex* has the primitive cylinders very distinct; they are of some size, and to the number of ten to fifteen occupy the central part of the cell; in *Talitrus saltator* the cylinders are smaller, but more numerous; in *Dexamine spinosa* they are very small and closely packed, and appear in section as fine granulations. Among the Isopoda, *Idotea linearis* has numerous cylinders, rather closely packed, and forming a central group which is surrounded by the richly nucleated protoplasm of the myogenic cell; in *Sphæroma serratum* the cylinders are very large, the protoplasm very abundant, and the nuclei of considerable size. In *Ligia oceanica* the myogenic cells fuse with one another, and the primitive cylinders are grouped in such a way as to leave an interval between themselves and the membrane of the cell; this interval is occupied by protoplasm, and the nuclei are small and not numerous. In *Conilera cylindracea* the primitive bundles are relatively colossal in size; the myogenic cells give rise to polygonal areas which may be as much as 0·08 mm. long and 0·025 mm. wide. In the parasitic Isopoda the primitive bundles are also large. The number of primitive cylinders and the size of the elements does not, in the Hedriophthalmata, appear to increase in direct relation to the size of the animal, for they are common in *Conilera*, smaller in *Cirolana*, and still smaller in *Ligia*, while in Amphipods they are larger than in *Gammarus*. The variations in histological structure are seen to be less remarkable in Amphipods than in Isopods, and in these latter orders there are often considerable differences in the size of the muscle-cells possessed by one and the same animal.

Development of Porcellio scaber.†—Dr. W. Reinhard comes to results essentially different from those of Prof. Bobretzky and Herr Nusbaum as to the formation of the germinal layers of *Porcellio scaber;* it may be noted that he has had the opportunity of studying phases of development earlier than those seen by the naturalists just mentioned. The nucleus of the egg-cell divides, and forms amœboid cells with part of the protoplasm; these, as they multiply, make their way to the periphery of the egg; when they reach it they become many-sided, and are converted into the cells of the ectoblast; this is not at first a thick layer but consists of several "islands." Under these several layers of cells appear, and between them the spaces become gradually filled up; the cells underlying the ectoblast form the primary endoderm, which only gradually becomes differentiated into mesoderm and endoderm.

The midgut is formed as an independent portion from the endodermal

* Comptes Rendus, civ. (1887) pp. 592–5.

† Zool. Anzeig., x. (1887) pp. 9–13.

cells in the anterior region of the germ; its wall gives rise to two forwardly directed outgrowths which flatten out and grow up on either side; these lateral walls rapidly fuse in the anterior region; before they do so, however, they give rise to two hepatic saccules. The hinder part of the gut partly closes up, but the median portion still remains open, and in contact with the nutrient yolk. The anterior side of the hindgut now lies very close to the midgut. The author was unable to find any of the so-called yolk-cells; the cells of the primary endoderm do not lie within but between the yolk-spherules, and the remarkable absorption of the yolk is only effected by the differentiating cells of the endoderm, which form the midgut and liver-saccules.

In *Porcellio* as in *Oniscus* (described by Nusbaum) the second pair of hepatic outgrowths is formed by longitudinal division of the outgrowths of the first pair.

Cepon.*—MM. A. Giard and J. Bonnier discuss the characters of the genus *Cepon*, a Bopyrid from Mauritius, which was discovered in 1840, but whose host was unknown; in 1881 it was found at Naples in *Portunus arcuatus*. Two new species have lately been discovered at Concarneau in *Xantho floridus* (*Cepon pilula*), and at Wimereux, where *C. elegans* is not very rare in *Pilumnus hirtellus*; the parasite is found in the upper part of the branchial cavity, and generally its hosts are young examples. The forms figured by Duvernoy as males are really young females not entirely transformed; the species found on Cancridæ hold to the *Cepon* of the Portunidæ the same relation as in *Entione* is held by *Cancrion* to *Portunion*; they are less profoundly modified just as are their hosts. The embryo of *C. elegans* has a considerable resemblance to that of *Phrynus paguri;* in both a young male and in *Entione* a *Cryptoniscus*-stage has been observed to succeed the first larval form, and as this has been found in *Bopyrina virbii* and in *Phrynus* this second larval stage may be supposed to be common to all the Bopyridæ; it is in this stage that they probably make their way into their hosts.

'Challenger' Isopoda.†—Mr. F. E. Beddard, who has already published a preliminary report on the 'Challenger' Isopoda here collects and illustrates his accounts. It is proposed to form a new genus, *Ianthopsis*, for *Ianthe bovalli;* and a few species are here described for the first time. Deep-sea Isopoda appear to be distributed very unevenly over the floor of the ocean, long stretches being altogether devoid of them. Thirty-four of the deep-sea species are blind, while in eighteen there are well-developed eyes; but of the eleven specially deep-sea genera representatives of two alone had eyes; the reason for some species retaining their eyes while others lose them on migration into deep water is perhaps to be sought for in the difference of the length of time that the respective species have inhabited great depths. Among Isopods the deep-sea fauna comprises many species which are larger than their shallow-water representatives, the colossal *Bathynomus giganteus*, described by Prof. Milne-Edwards, measuring nine inches in length. Deep-sea species often exhibit a great development of spines on the body; this is most noticeable among the *Arcturi*, but it is perhaps a character dependant rather on temperature than depth, for it has been observed in the species which inhabit cold regions.

Anatomy of Internal Male Organs of, and Spermatogenesis in Cypridæ.‡—Dr. F. Stuhlmann finds that the four testicular tubes of either

* Comptes Rendus, ciii. (1886) pp. 889–92.

† Reports of the Voyage of H.M.S. 'Challenger,' Monograph xlviii. (1887) 178 pp., 25 pls.

‡ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 536–69 (1 pl.).

side unite, in the Cypridæ, at the vas deferens; the so-called fifth or subsidiary testicular tube is only a cæcal appendage of the vas deferens which serves as a kind of reservoir for the spermatozoa; the vas deferens traverses the mucous gland or ejaculatory apparatus, and its cæcal appendage is not formed till a relatively late period in development. In quite young animals the testicular tubes only contain a syncytium and large cells; later on small cells, spindle-shaped cells, and finally spermatozoa appear. The whole of the vas deferens, inclusive of the ejaculatory apparatus, is gradually differentiated from a single homogeneous tubular mass. The nuclei of the syncytium at the tip of the tubes becomes the vesicular nuclei of the large cells; these divide several times, and more often in *Cyproïs* than in *Cypris punctata.* The nucleus of the small cell formed by division is spindle-shaped. In *Cyprois* it appears as if several spindle-shaped cells remain connected together. The nucleus becomes the central filament of the spermatozoa, in the formation of which only one nucleus takes part. In the glandular portion of the tube the spermatozoon increases in thickness and the central filaments become invisible. Owing to the movement of a spiral fringe the spermatozoon gradually passes into the upper portion of the vas deferens, and finally surrounds itself with a hyaline envelope; it is now ready to pass out, but is still almost immobile; the power of movement is only obtained in the receptaculum seminis of the female, where the hyaline envelope becomes striated.

Parasitic Copepoda.*—Mr. R. Rathbun describes various species of the genera *Pandarus* and *Chondracanthus;* he commences with a detailed description of *P. sinuatus*, which is only known from the imperfect account given of it by Say in 1817; *P. Smithii* is a new and large species, resembling in appearance rather *P. Cranchii* than *P. sinuatus;* three new species of *Chondracanthus* are described; *C. galeritus* is often found in the mouth of the common flounder (*Paralichthys dentatus*), and appears to correspond more nearly with the European *C. cornutus* than with any described species; *C. phycidis*, from the gills of the common hake (*Phycis tenuis*), has the anterior antennæ small and the thoracic appendages stout; *C. cottunculi* was found in the gill-cavity of two species of *Cottunculus*. The author confines himself to describing these species, and offers no remarks of more general interest.

New Lernæan.†—Prof. C. Claus describes *Lernæascus nematoxys*, a hitherto unknown Lernæan; it lives beneath the scales, especially of the pigmented side, of *Solea monochir*, is 8–10 mm. long, and has the appearance to the naked eye of a small Nematode. The anterior end is recognizable by the insertion of the antennæ, and the hinder by the two furcal processes; the abdomen is only 1 mm. long. The prehensile antennæ terminate in strong hooks; the tripartite entomostracal eye is perfectly retained. The mouth-organs consist of a sucking proboscis armed with two reversed hooklets and of two powerful maxillipedes; the mandibles are aborted, and the maxillæ are represented by stylet bristles placed outside the proboscis. Three pairs of limbs, consisting of minute feet, originate far apart; the first two are still biramose, but the third are simple wartlike tubercles furnished with two setæ. A character acquired by adaptation and quite peculiar to the genus is the presence of about fifty pairs of dorsal and a similar number of ventral scale-like finely striated elevations which extend over the whole of the thorax, and are of

* Proc. U.S. Nat. Mus., 1886, pp. 310–24 (7 pls.).
† Anzeig. Akad. Wiss. Wien, 1886, p. 231. Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 241–2.

essential service in the gliding movements executed by the parasite under the scales of its host. The stage described is that of an egg-producing female; males and females in the copulatory stage are scarcely one-third the length of the pregnant female, and nearly approach the type of the free-swimming Copepoda; the larger males are almost normally segmented, and have two pairs of swimming feet, modified to act as clinging organs; the smaller and more feebly constructed female has the segmentation reduced in the thorax and abdomen. The testes are remarkable for being moved down into the terminal segment, a change which obtains in the Argulidæ, but not among Copepods; the spermatophores are remarkably large, and extend as far forward as the antepenultimate thoracic segment. The prehensile antennæ are of the type of the Corycæidæ, and the two winglike plates on the back of the second thoracic segment remind one of the Pandaridæ; these are somewhat aborted in the ovigerous female, remaining as two pointed chitinous pieces.

Vermes.

α. Annelida.

Muscular Fibres of Polychæta.*—M. Jourdain has examined the minute structure of the muscles, especially those of the integument, of various species of Polychætous Annelids. Though the muscular fibres vary considerably in form they may be referred to two types: some are almost cylindrical, others distinctly lamellar; these are connected by intermediate types. The fibres consist of a contractile substance remarkable for its intense coloration and its homogeneous aspect, and of a nucleus which is accompanied by a more or less abundant protoplasmic body. In this contractile substance it is generally impossible to discover either transverse or longitudinal striæ; staining reagents, and especially hæmatoxylin, reveal segments which are alternately clear and dark, and which give the fibre an appearance "plutôt zébrée que striée;" these false striations correspond to true thickenings of the muscular substance, and have nothing in common with the striæ of vertebrate or arthropod muscle. A true striation has, however, been detected in *Protula intestinum*, which for fineness and regularity is comparable to what is seen in mammals; it can only be detected with the aid of immersion lenses. It is to be noted that tubicolous worms of the type of *Protula* are remarkable for the rapidity with which they contract and inclose themselves in their tubes.

Life-history of Thalassema.†—The development of a new species, *Thalassema mellita*, has been traced from the ovum to the adult by Mr. H. W. Conn.

The ova are very minute and remain free in the cœlomic fluid for a considerable time before entering the two pairs of anterior nephridia, or "sexual pouches." As the animal when very young enters and remains in the shell of *Mellita*, no copulation takes place. The vitelline membrane is excreted from the egg, which is, when discharged, filled with yolk-granules, and within this membrane is a peculiar modification of the superficial protoplasm, having the appearance of closely set, short cilia.

The eggs are not spherical, having one pole much less convex than the other, but immediately upon the entrance of a spermatozoon the egg becomes spherical. The vitelline membrane becomes raised up over this flattened area, and the polar bodies are here found—not until after the

* Comptes Rendus, civ. (1887) pp. 795–7.

† Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1886) pp. 351–99 (4 pls.). See also this Journal, 1884, p. 381.

entrance of a spermatozoon. The author considers that the space between the egg and the vitelline membrane is filled, not with a liquid, but with a gelatinous substance, which shows radiating striæ. After the extrusion of the two polar bodies, the true fertilization takes place, as is evidenced by the appearance of a large "aster" in the ovum.

The segmentation is perfectly regular, despite the quantity of yolk present, and results in a morula. When this has been converted into a blastosphere, cilia appear over all the egg, with the exception of a small area from which the endoderm will be formed. This layer arises by a process of modified invagination. As the cells become slightly inpushed, they increase in size and divide up, so as to form a solid mass. Thus there is no blastopore. A few of the ectoderm cells at the pole opposite the blastopore area, i. e. where the endoderm has been formed, are larger than the rest, and have long immobile cilia: this is the commencement of the supra-œsophageal ganglion. The body-cilia gradually become condensed to a ring round the body.

A cavity now appears in the endoderm, which will soon communicate with the exterior by a pore—the mouth. The larva elongates in a direction oblique to the axis through the ganglion and blastopore area. The archenteron becomes constricted into œsophagus, stomach, and intestine, which last elongates, attaches itself to the body-wall, and then communicates with the exterior. Thus, "neither the œsophagus nor the rectum is formed as a distinct invagination, i. e. there is neither true stomodæum nor proctodæum." The author refers to Hatschek's statement that the intestine of molluscs is an endodermal formation.

The larva has now become a trochosphere. The preoral band of cilia is carried by large cells, differing histologically from the remaining ectoderm cells, and there is a similar postoral band. There is also a broad band of cilia extending along the median ventral line, the cells bearing them being the rudiments of the nerve-chain. The cells of the ectoderm are crowded with peculiar "wormlike" unicellular glands, which produce a strong secretion, rendering staining difficult. In the ectoderm, also, are numerous muscle-cells, bearing a great resemblance to the epithelio-muscular cells of Cœlenterates.

The histological characters of the different regions of the alimentary tract are described, and the "ciliated ridge" which probably gives rise to the ciliated groove of the adult. The mesoderm consists partly of "mesenchyme," as in Echinoderms, and partly of true mesoderm, as in Annelids.

The later history of *Thalassema* is similar to that of *Echiurus*. The larval segmentation is very conspicuous, especially in the nerve-chain; this is formed as in *Lumbricus*. The ventral setæ are formed in small mesodermal sacs, which later on acquire an opening through the ectoderm to the exterior. The anal pouches arise as ectodermal invaginations, and funnels gradually arise. Mr. Conn was unable to find any trace of the larval excretory organ described by Hatschek for *Echiurus*.

The author, from the developmental history, agrees with the theory that the Gephyrea are extremely modified Annelids, while *Polygordius* is at the opposite end of the group. He would separate the Sipunculidæ from the Echiuridæ; and *Bonellia* would have to be placed apart from the latter, owing to its very different mode of development.

Several theoretical points are touched upon in this paper; one of them refers to the polar bodies. The author considers that the spermatozoon must exert a certain amount of influence on their formation, for if no spermatozoon enters the egg no polar bodies are formed. This has been

noticed in the case of two species of oyster, and in certain bony fishes. From various facts observed he considers that they are not the male portion of the egg-cell. The regular segmentation of the ovum is to be regarded as resulting from its free life; in most of the groups of the animal kingdom there are certain members whose eggs are not protected in any way, but which float freely from the first, and there segment regularly; whereas eggs which are protected either in capsules or in the parent's body and so on, segment irregularly. The cause of this is mechanical, and is not so much due to the yolk present, as to gravity.

Pelagic Annelids of the Gulf of Algiers.*—Dr. C. Viguier devotes the second part of his essay on the lower animals of the Gulf of Algiers to the pelagic Annelids, and to some general considerations on the constitution of the members of their order.

The pelagic Annelids may be divided into several groups; some, like the Heteronereidæ and the Syllidæ, which exhibit no alternation of generation, are for a short time only pelagic; others are pelagic for the whole course of their existence, but this is very brief,—they are the sexual stolons of Syllids with alternation of generation. The Annelids that are essentially pelagic all belong to the Alciopidæ or Phyllodoceidæ, with the latter of which may be associated *Tomopteris* and *Sagittella*. Of the forms enumerated by the author, five—*Maupasia cæca* g. et sp. n., *Iospilus phalacroides* g. et sp. n., *Alciope microcephala*, *Vanadis heterochæta*, and *Amblyosyllis algefnæ*—are new.

The author is of opinion that the head of an Annelid is typically composed of a single ring, formed directly from the trochosphere; this trochosphere first buds off the pygidium, which grows and becomes segmented. When the grooves which mark off the segments become apparent the first is seen to pass behind, or at least by the mouth; in cases of simple fissiparous reproduction, as e. g. in *Syllis fiumensis*, one of the rings of the primitive animal is very distinctly seen to be transformed into the head of the secondary individual, and alone to form its head.

On the basis of the conclusions to which he arrives M. Viguier tries to clear up the present confusion in the nomenclature of the parts of the Annelid; if we put aside the branchiæ, we may say that each segment of a free-swimming Annelid has only, on either side, a foot formed of a single or of two projections (dorsal and ventral). This foot normally carries a dorsal cirrus, which may be converted into an elytron, and a ventral cirrus below. These cirri may become greatly developed, or, as well as the foot itself, may become more or less completely atrophied. The cirri of the first or of the first few postcephalic rings often differ more or less profoundly, in form and development, from those of the rings which support them; generally speaking, their importance is, in one animal, in inverse proportion to that of the corresponding foot. He sees no reason for a change of names, and refuses to make use of the expressions tentacle or tentacular cirrus; where a note is necessary it is better to say that such or such cirri (using their number in order) are tentacularized.

The author commences his systematic account with the Phyllodoceidæ and the Alciopidæ, for between these families he is unable to draw any absolute line of demarcation. Accounts are given of *Pelagobia longocirrata*, which, unlike Greef, he does not place with the Syllidæ; of *Maupasia cæca*, the representative of a new genus and species, but the generic and specific characters are not technically distinguished in the account; *Hydrophanes Krohnii*; *Pontodora pelagica*, which, again, the author removes from among

* Arch. Zool. Expér. et Gén., iv. (1886) pp. 347–442 (7 pls.).

the Syllidæ, where it was placed by Greef; *Iospilus phalacroides* g. et sp. n. is an amended name for what the author first called *Ioda microceros;* what were taken for antennæ have since been found to be the palps. Some additions are made to Greef's account of *Phalacrophorus pictus.* Descriptions and notes are given of *Asterope candida, Alciope microcephala* sp. n., *Vanadis heterochæta* sp. n., and *Rhynchonerella capitata.*

Of the Tomopteridæ, which are rare in the bay, and generally, when found, are young, an account is given of *Tomopteris Kefersteinii.*

Of the Typhloscolecidæ, which are very rare, *Sagittella Kowalevskii* was alone recognized; of the Aphroditidæ there was a *Polynoe*, which may be pelagic, and if so may be called *P. pelagica.* Of the Eunicidæ, an account is given of *Ophryotrocha puerilis.* In the commencement of his account of the Syllidæ the author has some critical remarks on Prof. McIntosh's description of *Syllis ramosa;* of the forms without alternation of generation *Amblyosyllis algefnæ* sp. n. is described; of those with alternation, additions are made to Langerhans' account of *Virchowia clavata,* of which its original describer found only one example at Madeira, of *Autolytus prolifer,* and of *Myrianida fasciata.*

In his descriptions of the head the author recognizes on the lower surface, at the level of the mouth, the palps; in some Syllidæ there are occipital appendages which are called the ciliated lobes, and all the other appendages are anterior—either median, superior, or inferior; in the pygidium there are the lateral anal cirri, and the median pygidial appendages; on all the other segments, among which the buccal segment of authors is included, there may be a pedal mamelon, and a dorsal and a ventral cirrus.

Australian Polychæta.*—Of the family *Syllidæ* only two species have been described from Australia. Mr. W. A. Haswell describes seven new species.

Syllis corruscans is very remarkable from the presence of striated muscular tissue in the gizzard—"a tissue which has never before been described as occurring in Annelida." In this species there are innumerable unicellular glands in the hypoderm. The histology of the various organs is described. In the gizzard there is a thin cuticle, below which is the epithelium; an external and internal layer of ordinary non-striated muscle, and a middle layer of striated muscle arranged radially, the fibres of which present a nucleated protoplasmic core, with very marked striæ in their contractile portions. These rows of striated muscle have hitherto been regarded as transverse rows of glands. In the hinder portion of the intestine the epithelium contains numerous greenish concretions, which the author regards as being "of a uric character." The "segmental organs" (which the author differentiates from A. G. Bourne's "nephridia") are curved brown tubes opening on the ventral surface close to the parapodia. As usual, a combination of fission and budding occurs; the anterior dark-coloured region is female; the posterior orange-coloured portion is male; and this male form differs in many respects from the complete animal. *Syllis kinbergiana* shows many points of resemblance to *S. umbricolor,* from which it differs by the presence of three acicula in the parapodia. It is also related to *S. gracilis* and *S. hamata* and others. *Syllis tæniæformis* has uniramous feet, with three acicula, and twelve compound setæ, which have a short blade, bifid at the apex. *Syllis schmardiana* is somewhat similar to *S. erythropsis* and *S. vittata* Gr. In this species also striated muscular fibres occur in the gizzard; but the striæ are very few. *Syllis nigropunctata* is a small form, not unlike *S. variegata* Gr. *Gnathosyllis zonata* was in-

* Proc. Linn. Soc. N. S. Wales, x. (1886) pp. 733–54 (6 pls.).

complete posteriorly; no striations were observed in the radiating muscular fibres of the gizzard. Of the genus *Staurocephalus* a new species, *S. australis*, is described. *Eulalia quadrocula* is related to *E. microceros* Clap., but the new species has four pairs of eyes. *Psamathe* (?) *crinita* may turn out to be a type of a distinct genus. *Siphonostoma affine* is peculiar in possessing a pair of very long narrow cylindrical glands opening on the lateral dorsal surface of the body, just behind the head. These glands extend through a considerable portion of the body, have delicate walls, and contain cells inclosing small greenish particles. *Halla australis* is rich orange in colour, and from it a purple pigment is extracted by alcohol. There are seven pairs of jaws, some toothed, others not toothed. This species resembles *Nereis parthenopeia* Della Chiaje, but the latter has not the long whip-like setæ. Imbedded in the substance of the nerve-cord, in the anterior segments, are a series of eight or ten oval vesicles. Each is inclosed in a fibrous capsule, pierced by nerve-fibres, and contains a spherical solid body; the author suggests that they may be a rudimentary form of otocyst.

Conodonts.*—Herren J. V. Rohon and K. A. von Zittel have examined the structure of those enigmatical bodies which Pander regarded as the teeth of cartilaginous fishes of Silurian times, and find that all the forms consist of parallel-layered conical laminæ, arranged one over the other, and sometimes traversed by fine radial canals. The structure of these Conodonts has, then, nothing in common with the teeth of any fish, nor with the corneous teeth of Cyclostomi, nor can they be regarded as the lingual denticles of Molluscs, hooks of Cephalopods, or fractured points of Crustaceans; they do, however, agree admirably in form and structure with the buccal apparatus of Annelida and Gephyrea. Their great multiplicity of form leads us to suppose that they belonged to numerous genera and species, and consequently to the inference that in the Palæozoic times the shores of the sea were peopled with a great abundance of worms of very different kinds.

β. Nemathelminthes.

Embryology of Nematodes.†—M. P. Hallez has a note on the development of the mesoderm in round-worms; the layer starts from two cells which undergo division. As they do so the two mesodermic cells become smaller and smaller, while retaining their characteristic granular aspect; the two first cells grow larger and become very distinct, and will give rise to the gonad; by developing two cells posteriorly, they form the commencement of the genital ducts. Later on the two primitive cells are replaced by a small cellular mass, which is the ovary or testicle. The author has as yet been unsuccessful in making out the formation of the excretory apparatus.

The 16-stage appears to be important; in it there are four endodermal cells, of which the anterior and posterior will give rise respectively to the fore and hind parts of the intestine, while the two median give rise to the median part; there are the two initial cells of the mesoderm, two sexual cells, and eight ectodermal cells, of which the central is probably the point of departure for the cells of the central nervous system. Thus, from the beginning of segmentation, all the regions and all the organs of the new being are indicated.

* SB. Bayer. Akad. Wiss., 1886, pp. 108–36 (2 pls.).
† Comptes Rendus, civ. (1887) pp. 517–20.

Heterogamy of Ascaris dactyluris.*—M. Macé describes the development of *Ascaris dactyluris*, which live at the expense of the tissues of their mother, till its body is reduced to a mere sac. The young are now well advanced in development, the digestive apparatus being complete, and the reproductive organs containing products which are apparently matured; all these embryos are, without exception, females. The uterus is single and not double as in the parent form.

We have here a case comparable seemingly to that mode of development of the larvæ of the Cecidomyiæ which has been called pædogenesis, but it is to be noted that the reproductive individuals of these Nematoids appear to be less advanced than the viviparous larvæ of the Diptera. However, the author has not been able to see these eggs undergo development, but he believes that they escape to damp earth, and intends to investigate the question; if he proves to be correct in his supposition we shall have a case similar to that of *Ascaris nigrovenosa*, where the female gives rise to hermaphrodite ova; or, in other words, we shall have among Nematoids another instance of alternation of generations.

Heterodera Schachtii.†—Herr A. Strubell finds that *Heterodera* is a true Anguillulid, and stands nearest to *Tylenchus;* the sexes are distinguished by a remarkable dimorphism, the male having the characteristic nematoid form, and the adult female being spherical, and incapable of movement. The cylindrical body of the male is from 0·8–1·2 mm. long; the anterior part has a cap-like elevation which is separated from the rest of the body by a circular groove; the cuticle is distinctly ringed transversely, the rings extending all round the body, and being only broken at the lateral areas. The cephalic cap is to be regarded as the morphological equivalent of the lips. The lateral areas are broad and are divided longitudinally into three divisions; there is only one excretory vessel. There are four muscular areas, and in each there is seen, on transverse sections, five muscle-cells; the constituent elements are rather spindle-shaped than rhomboidal, and the medullary mass exhibits no processes of any kind. In Schneider's classification, therefore, *Heterodera* belongs to both the Polymyaria and the Platymyaria, and affords, therefore, a fresh proof of the untenable character of Schneider's classification. No anal nerve-ganglion could be made out.

The spine in the buccal cavity is stilet-shaped and hollow, and has at its base three knob-like thickenings; it is moved by three pairs of muscles. The last division of the œsophagus is chiefly distinguished by the presence of remarkably large nuclei. When the spermatozoa are in movement they emit extraordinarily long pseudopodia, which take on the most various forms.

The female of *Heterodera* has the form of a lemon with the poles drawn out; one of these processes is pretty sharply marked off from the chief mass, and is seen to be the cephalic portion by the presence of a spine; the dorsal is always more strongly curved than the ventral surface; the anus lies near the vulva and dorsally. In place of the transverse annellation of the cuticle there are five knobs and ridges which generally take a horizontal direction; the lateral areas cannot be detected from the exterior. The genital apparatus consists of two tubes, which unite to form a common vagina; between the oviducal and uterine portions of each tube there is a receptaculum seminis.

The ovum is bean-, or kidney-shaped, and is inclosed in a firm structureless shell; the yolk-elements are very large. Eggs at various stages of

* Comptes Rendus, ciii. (1887) pp. 306–8. † Zool. Anzeig., x. (1887) pp. 42–6, 62–6.

development may be found in the uterus; segmentation is irregular. As noticed by Goette, two large round cells lying symmetrically in the ventral region and near the middle of the body appear early; they disappear as soon as the rudiments of the gonads become apparent. Histological differentiation of the various organs is effected very rapidly. In the post-embryonal development of *Heterodera* there is a metamorphosis; the appearance of a pupa-stage in the male is especially interesting. The first larval form is an agile worm, very much like the male in organization; this takes to a parasitic mode of life—in beet-root—and the second larval form appears as a flask-shaped body; this grows and the root of the plant incloses it. Up to this stage the animals are sexually indifferent, but differences soon begin to be apparent; the greatest changes are now effected in what will be the males; the length of the whole development depends on external conditions, chiefly warmth and dampness; it is generally effected in four or five weeks. The history of the metamorphosis is unlike any known among Nematodes, or even in Acanthocephala; among the Arthropoda, the greatest resemblance is shown by the Coccidæ, where too the female remains at a larval stage.

Asconema gibbosum.*—Prof. M. Braun, in a notice on this remarkable Nematode, heads his remarks with "*Atractonema gibbosum*" and states that in the separate copies of his paper, Professor Leuckart made a MS. change of the generic name, as *Asconema* was already in use for a fungus.

Structure and development of Cysts of Echinorhynchus.†—M. R. Koehler comes to conclusions, with regard to the cysts of *Echinorhynchus angustatus* and *E. proteus* found in the barbel, different to those published by M. Mégnin five years since. The smallest cysts, which are not more than some tenths of a millimetre in diameter, appear as small white dots on the surface of the intestine or of the peritonæum. They have a thick envelope formed of several concentric layers of a connective tissue, rich in nuclei, and there is a central granular mass formed by the union of a large number of small cells. This cellular mass, which is spherical in the youngest cysts, becomes ovoid, and is then differentiated to give rise to a proboscis of an *Echinorhynchus* on which the characteristic hooks appear. The hooks are formed from before backwards. At the hinder extremity of the proboscis there soon appears a small bud which gradually elongates; this is hollow and contains a central cord—the genital cord. The posterior region is reduced to a very delicate prolongation, which is rounded and a little swollen at its extremity, but is much narrower than the proboscis of which it appears to be merely an unimportant appendage. In no case was the cyst found to contain an animal provided with lemnisci, and if these organs do appear within the cyst they can only do so much later on. They arise behind the proboscis, and have the same structure as in the adult. When the largest cysts are examined but few are found to have their elements intact, nearly all are hard, and can only be broken or cut with difficulty. The rudiment of the *Echinorhynchus* appears to have undergone a special degeneration which has made it hard and friable.

The *Echinorhynchi* which are found in the digestive tract of the barbel, fixed against the walls of the intestine, arise without doubt from larvæ which have passed their early stages in a *Gammarus* or an *Asellus*. In other words, the cysts found in the peritonæum do not give rise to the parasites found in the intestine. The origin of the former still remains unknown, and suggestions as to it are all that can yet be made.

* Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) pp. 212–3.
† Comptes Rendus, civ. (1887) pp. 710–2.

γ. Platyhelminthes.

Leuckart's 'Die Parasiten des Menschen.'*—Prof. R. Leuckart has published a further instalment of the second edition of his classical work on human parasites; in this the development and structure of *Bothriocephalus* continues to be described. In addition to the well-known *B. latus* there are accounts of *B. cordatus* and *B. liguloides* (= *Ligula mansoni* Cobbold). In an appendix of additions and corrections the author brings this volume, the issue of which began in 1879, up to date, giving interesting information regarding the increase in our knowledge of parasitic Protozoa, and a *résumé* of the advances in the history of the Cestoda. The structure and life-history of the Trematoda is commenced in the first few sheets of the next part. So far as Protozoa to Cestoda are concerned the work is now accessible to those who read only English.†

Anatomy of Bilharzia.‡—M. J. Chatin states that the fine spines found on the integument of *Bilharzia* are more numerous and better developed in the female than in the male; these spines have, no doubt, a greater morphological value than has ordinarily been attributed to them, for they must play a certain part in the lesions of the capillaries which are caused by the presence of these parasites. The muscular body-wall is only moderately thick as compared with that of other Trematodes. The œsophagus, which is at first narrowed, widens out, and becomes curved; where the two limbs of the stomach join there is a small median cæcum, which ought properly to have the name of intestine; its slight development, and its variation in sexes and individuals show that it is of no great value physiologically; unlike what happens in most of its allies, *Bilharzia* has the enteric muscular layers poorly developed, even in the region of the pharyngeal bulb. As M. Chatin has been able to detect in some examples of *Distomum lanceolatum* a tendency to the approximation of the two cæca he thinks that *Bilharzia* may be allied to the typical genus of the Trematoda. An account of the excretory and generative apparatus is reserved for another communication.

Excretory and Reproductive Systems of Bilharzia.§—M. J. Chatin has made a careful study of the excretory apparatus and reproductive organs of *Bilharzia*, in regard to which our knowledge has been hitherto almost confined to the original, and apparently inexact description of Bilharz.

(*a*) The well-developed excretory system has a posterior contractile orifice, into which there opens an elongated reservoir, receiving the two lateral and single median vessels. The main vessels, which are lined by a definite membrane, divide and ramify, with a marked reduction in the male.

(*b*) When macerated in dilute alcohol, the testes separate from one another, and are seen peripherally to consist of fine tubules continued into the seminal ducts. These extend to the vas deferens, which before passing into the "gynæcophorous canal" dilates into a simple prostatic, certainly not penial sac.

(*c*) The small, lateral ovary of this remarkable diœcious Trematode is masked by a portion of the uterus, is slightly four-lobed, and connected by a short oviduct with the junction of the albumen duct and the stalk of the shell-gland. (*d*) The albumen glands form numerous lateral lobes com-

* 'Die Parasiten des Menschen,' Bd. i. Abth. 1, pp. 855–1000, title-page and xxxi. pp.; Bd. i. Abth. 2, pp. 1–96.

† 'The Parasites of Man,' translated by W. E. Hoyle, 8vo, Edinburgh, 1886, 771 pp. and 404 figs.

‡ Comptes Rendus, civ. (1887) pp. 595–7.

§ Ibid., pp. 1003–6.

municating with a central canal, which dilates before ending near the oviduct. The structure of the gland recalls that of Diplozoon. (*e*) The irregularly conical shell-gland, prolonged superiorly, and borne on a short broad stalk. It is covered with a connective-tissue membrane, lined by a thick epithelium, and often contains only a single egg as in several Polystomeæ. (*f*) The adjacent uterus is first expanded, then narrowed, again dilated and again contracted before opening in a small depression, protected by a musculo-cutaneous fold. (*g*) In the region occupied by the oviduct, the albumen duct, the uterus, &c., there is a small blackish tract directed dorsally, and apparently representing the canal of Laurer, though without visible external aperture.

(*h*) The seminal fluid passing from the ejaculatory duct probably flows into the gynæcophorous canal, and is led by the ventral groove in the female to the opening of the uterus. The almost permanent copulation secures fertilization.

Sexual Characters and Generative Organs of Microstomida.*—Herr D. Rywosch has examined *Microstoma lineare* and finds that it is not thoroughly bisexual, and indeed he is inclined to regard it as a completely hermaphrodite form; solitary males were never observed; in the anterior individual of a chain male generative organs were never found. The generative organs do not appear to become completely matured till an individual leaves the chain. The generative organs are ventral in position, and the female in front of the male; the author differs from Vejdovsky in regarding the testes as always single and never double. The penis varies in form, having sometimes the appearance described by Schultze, and sometimes that described by Graff. The ovary is a club-shaped tube formed by a structureless membrane and a number of egg-cells, not divided by constrictions; the ova are always developed from the median cells, and as they grow the number of bounding cells increases; these are used as food for the egg. The ovary passes into a distinct efferent duct, which opens on the median ventral line; the duct is invested by small cubical cells which are strongly ciliated, and by tubular granular glands. The presence or absence of sexual forms in autumn, as to which Schultze and Graff are in disagreement, appears to depend on climatic conditions.

Anatomy of Schizonemertini.†—M. R. Saint-Loup gives an account of the cephalic pits of *Cerebratulus viridis*, and *Ophiocephalus Elizabethæ;* he describes in the former a pillar which traverses the central mass; in it there are a longitudinal and two lateral canals which are so disposed that the cavity which contains the substance impregnated by hæmoglobin communicates with the exterior by the lateral ducts as well as by the cephalic pits; all the canals, with the exception of one which leads to the pharynx, are ciliated. In *Ophiocephalus Elizabethæ* the communications between the "pericerebral cavity" and the exterior are similarly arranged, but there does not seem to be any duct leading into the pharynx; the ducts end in the hæmoglobinoid substance, and are there enveloped with strongly coloured brownish-yellow granulations; so that an excretory glandular formation appears in the tissue to which respiratory functions are ascribed. In neither of these two forms does the author find the hepatic tissue noticed by M. Marion in *Borlasia Kefersteinii*, nor the uric acid concretions which have been observed in *Tetrastemma flavidum;* there are, however, granulations of a dark brown colour abundantly developed in some parts of the digestive tract. It seems, therefore, that Nemertines differ as to the localization of elements

* Zool. Anzeig., x. (1887) pp. 66–9. † Comptes Rendus, civ. (1887) pp. 237–9.

which have the same chemical function in the economy. The author has noted similar facts in the Hirudinea, and has shown the relation borne by the so-called hepatic tissue to the pigmented dermal ones. It is interesting to prove, in animals where the circulatory apparatus does not contain blood-corpuscles, that there is a migration of the corpuscles which seem to have a chemical action in the phenomena of assimilation, respiration, and excretion.

δ. Incertæ Sedis.

Rotifera.*—In Prof. A. G. Bourne's general essay on the Rotifera, the most interesting point noticed is, perhaps, the relations of the trochal disc. He accepts the view that the anus of veliger forms always forms so as to leave the primitive ciliated ring ("architroch") post-oral; that this architroch changes its position on the development of a prostomium, and that the two lateral portions come to lie longitudinally. These may be supposed to have coalesced so as to leave two rings—the one præoral, cephalotroch, and the other post-oral, branchiotroch. Among Rotifers the simplest condition is seen in *Microcodon*, where there is a single circumoral ring; if this be thrown into folds we get the conditions which obtain in *Stephanoceros*; further stages of complication through *Philodina*, *Lacinularia*, *Melicerta*, where both cephalotroch and branchiotroch are thrown into folds, lead to *Brachionus* where the cephalotroch becomes first convoluted, and then discontinuous. With regard to their power of resisting desiccation, Prof. Bourne expresses himself thus: "Many Rotifers exhibit an extraordinary power of resisting drought. Various observers have dried certain species upon the slide, kept them dry for a certain length of time, and then watched them come to life very shortly after the addition of a drop of water. The animal draws itself together so that the cuticle completely protects all the softer parts and prevents the animal itself from being thoroughly dried. This process is not without parallel in the higher groups." The Rotifera must be kept apart from the Mollusca, Arthropoda, and Chætopoda in our systematic classifications.

Key to the Rotifera.†—Dr. T. S. Stevens has prepared a key to facilitate the use of Hudson's and Gosse's Monograph on the Rotifera, and including only the genera and species described in that work. The intention is no doubt good, but the result is not satisfactory. It may possibly be of use to beginners, but no one but a beginner would be likely to make use of it; for it is perilously artificial, resting sometimes on a few comparatively unimportant characteristics. There are, too, obvious mistakes. *Apsilus* is said to be a free-swimming or floating genus, whereas it is a fixed one. *Floscularia* is set down as both a free-swimming genus and a fixed one; and though this may be defended because the genus has one free-swimmer, or rather one bad adherer, yet it would be puzzling to a beginner using the key. Again, *Limnias* and *Melicerta* are placed in the same group with *Floscularia* and *Stephanoceros*, in spite of the wide diversity in the position of the buccal orifice with respect to the body's longitudinal axis, thus showing how artificial the plan of the key is. The real difference in structure between *Callidina* and *Adineta*, that of the corona, is entirely missed, and the two genera (in the key) are made practically identical.

* Ency. Brit., xxi. (1886) pp. 4–8.
† Journ. Trenton (N.J.) Nat. Hist. Soc., 1887, pp. 26–43.

Echinodermata.

So-called Heart of Echinoderms.*—Professor E. Perrier, referring to the recent essays by M. Prouho, who disagrees with his results, and by M. Cuénot, who agrees with what he has taught as to the so-called heart or plastidogenous body of Echinoderms, resumes the history of our knowledge of this organ. He thinks that M. Prouho's results are not so essentially different from his as that author seems to suppose. He suggests the term *organe plastidogène* for the ovoid gland, as it is an organ which produces anatomical elements; he cannot believe that it has an excretory canal by means of which it is put into relation with the exterior, and he is inclined to agree with M. Kœhler's interpretation of the body as an appendage of the so-called vascular apparatus.

Organization of Echinoidea.†—M. H. Prouho, referring to some disputed points in the anatomy of sea-urchins, describes the water-vascular system; in *Dorocidaris* he finds an aquiferous system which communicates with the exterior by means of the madreporite, and which is formed of canals invested by a vibratile endothelium; there is also a "système vasculaire sanguin," or blood-vascular system, for which the author prefers the name of "système visceral vasculo-lacunaire"; this is in great part formed not of vessels, but of lacunæ hollowed out in the mesentery and its appendages; the internal marginal vessel is only a vast interstitial lacuna; at the level of their œsophageal rings these systems are closely applied to one another, but do not communicate; an exchange of currents between the two is impossible. The only changes that can be effected are such as are of an osmotic nature; a true diapædesis probably occurs. The visceral vasculo-lacunar system has no communication of any kind with the exterior. The canal which Professor Perrier calls the excretory canal of the ovoid gland is not a dependence of this system, but is an appendage of the aquiferous apparatus which allows the water that enters by the madreporite to come into contact with the walls of this gland. No exchange can be effected between this canal and the contents of the visceral plexus distributed to the walls of the ovoid organ, for it is opposed by a continuous epithelium. The term excretory canal appears to have led to a misunderstanding, and may therefore be well replaced by "annexed aquiferous duct." The contents of the aquiferous system are moved by the vibration of the endothelium of its vessels; while those of the vasculo-lacunar system can only move by a *vis a tergo* due to the repletion of the intestinal absorbents.

The two systems of canals and lacunæ aid in forming the perivisceral fluid which not only circulates actively around the viscera, but is also found in the cavity which is absolutely shut off from the visceral, and which contains the "lantern of Aristotle." The branchial appendages of the Cidarids are, as is now well known, internal and not external, and float in the general cavity. The author regards them as organs charged with the function of keeping an equilibrium between the liquid of the lantern and the perivisceral fluid which is outside it; this equilibrium is not one of pressure but of osmotic action.

Movements of Star-fishes.‡—Prof. W. Preyer's subsidiary title to this memoir will probably be a little astonishing to those who look on Echinoderms as some of the "lower Invertebrates"—it is "a comparative physiological-psychological investigation." The author was led to under-

* Comptes Rendus, civ. (1887) pp. 180–2. † Ibid., pp. 706–8.
‡ MT. Zool. Stat. Neapel, vii. (1886) pp. 27–127 (27 figs.).

take the study of Echinoderms by the reflections raised by the observation of the physiology of the embryos of higher animals, many movements of which appear to be long inherited. After enumerating the twenty-one species on which he experimented, he speaks shortly of the work of previous observers, and expresses, *à propos* of the papers of Messrs. Romanes and Ewart, the very reasonable desire that physiological works should state definitely the species on which experiments were performed.

The ambulacral pedicles of Asterids are polydynamous organs of a special character; their mobility and sensitiveness, their large number, suctorial function, together with their locomotor and respiratory significance cause them to be of great interest. It was especially interesting to investigate the causes of the retraction and erection of these organs, which are capable of all kinds of vermiform movements and twistings; so long as the animal is quite fresh and normal, extension is more rapidly effected than retraction. The fundamental phenomenon is that which was long since mentioned by Tiedemann—the retraction of the suckers on slight mechanical irritation; dorsal irritation of a ray is almost but not quite as speedily followed by retraction of the suckers underlying the region touched; the extent of irradiation, or distance to which the stimulus exerted its effect, was found to vary with different species, but it was generally found that, in all five-rayed star-fishes, there was an almost simultaneous retraction of the central feet of the two neighbouring rays, and in very many cases of the remaining two later on. Chemical stimuli have a generally similar effect to mechanical stimuli.

Isolated rays were next examined and confirmed Romanes' observations; but differences were observed with different species, *Luidia* not responding as well as *Asterias*, and indicating that in it peripheral reflex actions were not so much independent of the central organ as in the less mobile and otherwise less sensitive species of *Asterias* and *Astropecten;* in the latter the radial medulla (an ambulacral spinal cord in the physiological sense) is more autonomous or less dependent on the ambulacral brain, or central nerve-ring with its rich supply of ganglionic cells.

With regard to the extension or erection of the suckers, it was found that strong centrodorsal mechanical irritation extended centrifugally into all the rays, but when it is weak the effects may be confined to the circumoral feet, and be transitory. The extension of the suckers after local dorsal stimulation is always a central process; if the centres are wanting or injured, and their connections broken, the extension is affected. The details of experiments with electrical and thermal stimuli are also given.

It is clear from these experiments that—

(1) If, on an uninjured star-fish, a local ventral or dorsal stimulation exerts only a local effect there is always a retraction, and never an extension of the ambulacral feet.

(2) If a local dorsal stimulus irradiates, a general extension from the centrum follows, and never a retraction; thus:—

Place of stimulation.	Result.
Dorsal. Excentric or "dorsal"	Local: Retraction. Irradial: Extension.
Ventral. Excentric or central	Local: Retraction. Irradial: Retraction. / Extension.

After describing the phenomena of attachment to foreign bodies, of creeping, and of climbing, the author enters upon an interesting account

of the way in which star-fishes and brittle-stars right themselves, or return to their normal position; the description given by Mr. Romanes and Prof. Ewart is, generally, exact, but the exact method of righting is not the same in all the species of star-fishes, though brittle-stars much more closely resemble one another. The experiments were varied by the application of drugs, differences of temperature, and weights. The result of all is the definite conviction that the movement is not due to any external peripheral reflex stimulation. The impulse which comes to the central organ, or (in Asterids) to the subordinate centres of the radial medulla of separate pieces of the rays must, it may be thought, be either central or centripetal; against the former supposition, which would be explained by imagining that the abnormal position had caused a disturbance of the circulation, Prof. Preyer cites certain experiments on frogs; and the same objection may be raised to the second suggestion. What explains the righting of frogs—namely the "muscular or innervation sense"—may be applied also to Echinoderms.

The memoir concludes with some observations on movements away from an object, such as an attempt by an Ophiurid to get away from or free itself of a tube drawn over one of its arms; the author describes the five different ways in which the brittle-star acted; when the tube was loose, it tried to rub it off by drawing along the floor of the aquarium; when the tube was rather tighter it tried to shake it off, or held it down with the neighbouring arms and tried to draw the median arm out, or it tried to push it off with the two neighbouring arms, or it broke off the arm that was covered by the tube. It is impossible to refer such phenomena as these to simple reflex action; the Ophiurids rather possess the power to adapt themselves to quite new situations, such as they have not experienced before. If intelligence depends on the power of making experiments, that is of learning, and making use of what is learnt in a new way, then Ophiurids must be very intelligent. Complicated movements of a like kind were never seen in Asterids.

Homologies of Larvæ of Comatulidæ.*—M. J. Barrois thinks that the facts that the closure of the blastopore of the larva is effected not far from the spot at which the opening of the calyx appears later on, and that the ventral pit corresponds in situation to the buccal invagination of the other larvæ of Echinoderms, should show us that we ought not to consider the region of the calyx as anterior and that of the peduncle as posterior, but *vice versâ;* the pentacrinoid, then, cannot be considered as arising from a larva fixed by its posterior part, but as one fixed by its preoral lobe.

Researches on the metamorphoses of Echini have led the author to conclude that the larva ought to be considered as being composed of two parts, an anterior formed by the portion which projects above the subumbrella, that is, the preoral lobe and the œsophageal region, and of a posterior part composed of the rest of the body; during metamorphosis the former is detached at its base, and the latter is transformed into the urchin. These two parts correspond to the two fundamental divisions (calyx and peduncle) of the larvæ of Comatulids.

Cœlenterata.

Natural History of Hydra.†—Continuing his studies on the divisibility of living matter Herr M. Nussbaum has devoted his attention to the genus *Hydra*, of which he gives a monographic account.

* Comptes Rendus, ciii. (1887) pp. 892–3.
† Arch. f. Mikr. Anat., xxix. (1887) pp. 265–366 (8 pls.).

He distinguishes four species, noting the diagnoses and synonyms, viz. *Hydra viridis*, *H. grisea*, *H. fusca*, and less certainly *H. attenuata* of a pale straw-yellow colour. A careful and detailed account is then given of the histology of this organism which has been the subject of so many investigations. From the nature of the case the results are rather corroboratory than novel.

The second part of the memoir is devoted to a description of the author's numerous experiments on the familiar power of regeneration and wound-healing exhibited by mutilated polyps. Slices were cut out of the body in any direction, and divided into four or so portions, which regenerated new organisms. As has been previously noticed, the experiments of Trembley as to the survival of *Hydra* after being turned inside out are confirmed, while it is further shown that there is no modification of ectoderm into endoderm, and endoderm into ectoderm, but that new growths restore the old layers. An ectoderm grows over the exterior, and the elements, no longer able to continue in their reversed conditions, are absorbed and replaced by fresh cells. The concluding chapter of Nussbaum's paper is an interesting historical sketch.

Nematocysts of Hydra fusca.*—Mr. R. J. Harvey Gibson, by the use of eosin and some specially large *Hydræ*, has been able to make out distinctly the anatomy of the resting stage of nematocysts; the wall is firm, transparent, and more or less elastic; it is occasionally surrounded by a clear crescentic space, which intervenes between the capsule and the protoplasm of the ectoderm-cell; at the narrower end of the capsule a distinct depression can, under a high power (Zeiss 1/12 in. oil-immersion), be made out; on one side of this rim there is an appearance of discontinuity in the substance of the capsule. In the interior of the capsule there is a funnel-shaped membranous tube which at about one-third of the length of the capsule becomes enveloped in a general mass which occupies the rest of the space. Mr. Gibson calls this tube the "pharynx." When a living *Hydra* is "irrigated" with dilute acetic acid, the pharynx and an enormously long thread are everted: to investigate the stages of eversion a living tentacle was stimulated with acetic acid, and this was immediately followed by the application of a small drop of one-quarter per cent. osmic acid. Most of the nematocysts were arrested in the act of exploding; some had only the pharynx evaginated; some, in addition, had a thread about four times the length of the capsule protruding, and that thread was double the usual thickness of the entirely everted thread; in those in which the evagination of the thread had been arrested in its last stage there was a long club-shaped extremity; in most of these and also in the partially everted threads, careful focusing revealed another thread distinguished by its faint spiral twist. The author is of opinion that, though the forces which bring about the evagination of a nematocyst may be physical, they are under the command of the *Hydra;* the initial act in the process is the dissolution of continuity between the lid and the capsule.

The development of the nematocyst commences with a granular differentiation of the protoplasm in any part of the cell; the granule grows and becomes a circular sac; at one point an invagination is made, and the coiled finger-like process grows and coils round and round the central tube; the capsule broadens and the central pharynx developes the arrow-head spikes of the adult nematocyst.

Living parasitically was a species of *Euplotes* which wanders freely all over the *Hydra;* they were found to contain many nematocysts, both large

* Proc. Lit. and Philos. Soc. Liverpool, xxxix. (1885) pp. 29–38 (1 pl.).

and small, which had obviously been swallowed. It is not understood why the *Hydra* does not discharge nematocysts at them, or why the cysts themselves do not explode in the interior of the parasite.

Stinging Cells.*—M. M. Bedot has studied the structure and development of the stinging-cells in Velellidæ and Physalidæ. He notes the importance of confining the term cnidoblast to the cell which gives rise to the nematocyst or homogeneous capsule inclosing the filament. In Velellidæ four kinds of cnidoblasts are described—small and large, either with or without stalk. The large cnidoblasts inclose large oval nematocysts with a handle, and the filament rolled very regularly within the capsule, while the small nematocysts in the small cnidoblasts are more elongated, have no handle, and the filament irregularly disposed. In Physalidæ two kinds are distinguished, differing in length of stalk and size of nematocyst.

After noting the various modes of distribution and arrangement, the author proceeds to give an account of their development. Before the stinging-pad is formed, a section of a tentacle exhibits among the ectoderm cells certain cnidoblasts with nematocysts in process of formation. The ectoderm thickens at two opposite points. The developing cnidoblasts come to the surface, but remain attached to the supporting mesoderm layer. The lengthening of the stalks of the cnidoblasts is not the cause, but the effect of the formation of the pad. The formation of the gelatinous tissue of the tentacles is also described. To follow the development of the nematocysts, a piece of the central organ should be separated. The first trace of the appearance of the nematocyst in the simple cnidoblast is the formation of a vacuole which grows in the protoplasm. From the margin of the vacuole a little bud grows into the transparent contents. This is the nematoblast which gives rise to the stinging filament. In Physalids this rudiment increases as a pear-shaped bud, a canal appears in the stalk and extends into the swollen portion, the protoplasm condenses round the canal and forms a wall. The envelope of the nematocyst is formed by the transparent substance which fills the primitive vacuole. In both Physalids and Velellids two nematocysts may be formed within a cnidoblast. In Velellids the development is complicated by the presence of the handle of the filament. The nematoblast appears as a minute sphere. Opposite the stalk a prolongation grows out, representing the filament. The sphere itself forms the first portion of the handle, while a second spherule near the filament forms the other portion of the handle and hooks.

New Rhizostomatous Medusa.†—Mr. J. W. Fewkes describes a new medusa, the only non-tentaculated member of the group known, as yet, on the Atlantic coast of North America, and he gives it the name *Nectopilema Verrilli.*

Owing to the damaged condition in which it was found, only an imperfect description is possible; and only the margin of the umbella and oral arms are touched upon.

The new genus belongs to Häckel's family Pilemidæ, and probably to the sub-family Eupilemidæ. Its nearest allies appear to be *Pilema* and *Rhopilema;* and it serves to connect the sub-families Eupilemidæ and Stomolophidæ.

New genus of Stylasteridæ.‡—Mr. R. Kirkpatrick describes a new Stylasterid from Mauritius, for which he proposes the name of *Phalangopora regularis* g. et sp. n.; it is allied to *Errina*, but differs in having the gastro-

* Rec. Zool. Suisse, iv. (1886) pp. 51–70 (2 pls.).
† Amer. Journ. Sci., xxxiii. (1887) pp. 119–25 (1 pl.).
‡ Ann. and Mag. Nat. Hist., xix. (1887) pp. 212–4 (1 pl.).

pores in single linear series; the separation of the gastropore and dactylopore systems is a further distinctive feature.

Coral Studies.*—Dr. A. R. v. Heider is led by the study of *Astroides calycularis* and *Dendrophyllia ramea* to some general considerations as to the structure of corals. He is firmly convinced of the presence in intact living corals of an outer soft investment to the theca; in colonial forms the body-walls of the polyp very soon pass into the cænosarc which connects the separate individuals, and then the investing part becomes very hard to detect. In the solitary form it is otherwise, and in *Dendrophyllia*, for example, the outer investment is often considerably longer than the polyp. This outer thecal covering or marginal plate, has not the same composition in all corals; in *Cladocera*, *Dendrophyllia*, &c., all the three layers are present; but in *Astroides* and *Flabellum* (according to Prof. Moseley) the outer surface of the skeleton is formed directly of a simple layer of meso- and ectoderm, and there is no continuation of the body-cavity between the theca and the body-wall.

It is, morphologically, a very important fact that in one group of corals which, according to present systematic arrangements, consists of members of various families, the theca is formed quite independently of the body-wall, and that in another group the body-wall takes up the theca into its mesodermal layer. If this generalization be correct we have two divisions of Madreporaria: that of the Euthecalia in which the body-wall secretes calcareous substances within its mesodermal lamella, and forms an "eutheca" which ultimately becomes connected with the septa; and that of the Pseudothecalia, in which the body remains connected with its three layers and secretes no theca, but in which the septa become connected by calcareous substance at their peripheral ends, and so form a "pseudotheca," outside which is the continuation of the body-cavity. In skeletons deprived of their soft parts it is, of course, difficult, or even impossible, to determine how the theca has been formed; the author is inclined to think that well-developed costæ are associated with a pseudotheca.

It would appear that the ectodermal layer of the young polyp which excretes the calcareous matter is completely surrounded in time by the mesoderm; the author does not agree with Dr. von Koch in thinking that the cells persist and excrete lime, but that they are converted into it, and that, therefore, they cease to exist as cells.

Anatomy of Fungia.†—Mr. G. C. Bourne describes the arrangement of the tentacles and septa, which is very regular in *Fungia*, and not irregular, as has previously been supposed. Prof. Duncan's doubt whether there were any mesenteries is shown to be unfounded, and indeed, they have all the essential characters of the mesenteries typical of Hexactinian Actiniaria; seven orders correspond to the seven orders of septa. There are no synapticulæ in the upper portions of the interseptal loculi, where the mesenteries are free to radiate across the whole space between the mouth and the periphery of the disc; here then is the ordinary central structureless supporting lamina which the author proposes to call the mesoglœa—this new term being the equivalent of the German "Gallertlage"—of which the bodies of Medusæ are for the most part made up.

The cœlenteron is represented by the axial space lying below the stomodæum, the peripheral chambers known as exocœles and endocœles, and the space which lies between the theca and the outer body-wall; the complicated relations of their parts only seem to be explicable on the theory of

* Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 507–35 (2 pls.).
† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 293–324 (3 pls.).

von Koch, that the corallum is derived primitively from the basal ectoderm, and that the theca is formed by the fused peripheral parts of the septa, which in fusing divide the mesenteries, and leave a portion of the cœlenteron external to the theca. During life the animal constantly closes the middle portion of its mouth, apertures being left at either end by which water passes in and out.

The histological characters of *Fungia* are simple and conform to the Actinian type. Dealing specially with the mesoglœa of the Cœlenterata, the new name appears to be justifiable on the ground that the tissue does not seem to be homologous with the mesoblast of the Triploblastic Metazoa; in the Hydromedusæ it is a fine, apparently structureless membrane placed between endoderm and ectoderm; in the Siphonophora it is a structureless jelly-like substance; in the Scyphomedusæ it is structureless, but has a fibrillar arrangement; in the Discomedusæ (Aurelia) it contains a number of oval or stellate cells, and in the Ctenophora there are muscular stellate cells. In the Alcyonaria, cells lie imbedded in a gelatinous matrix and in them the calcareous spicules of the skeleton are developed; in the Actiniaria Madreporaria the lamina is fibrillar and contains a few connective-tissue cells. Various arguments against its complete homology with the mesoblast are advanced by the author.

Arrangement of the Mesenteries in the parasitic larva of Halcampa chrysanthellum (Peach).*—Prof. A. C. Haddon gives a bibliography of all the Actiniæ known to occur as parasites on Medusæ. It appears that *Halcampa fultoni* is the larva of *H. chrysanthellum* (N. Europe); *Philomedusa vogtii* and *H. medusophila* are probably the young of *Halcampella endromitata* (Mediterranean); *Bicidium parasiticum* is a *Peachia* (N.E. America); lastly there are *Halcampa clavus* (Southern Ocean) and a parasitic larval *Edwardsia* (N.E. America). A description of the larva of *H. chrysanthellum* is given. Only eight tentacles are present. In the œsophageal region the twelve mesenteries appear to have equal importance. A deep siphonoglyphe is present which extends for a short distance below the œsophagus. In the gastric region there are eight large mesenteries which alone bear the enlarged digestive borders; the other four mesenteries are shorter and have smaller muscular bands than the former. Those four intra-mesenterial chambers, which are bounded by a strong and a weak mesentery, are alone not prolonged into a tentacle. The dorsal directive mesenteries also appear somewhat smaller than the remaining six strong mesenteries. From the position of the muscular band it is evident that the eight strong mesenteries of the larval *Halcampa* are homologous with the eight mesenteries of *Edwardsia* and not with the eight strong mesenteries of other larval Actiniæ. It is interesting to note that no siphonoglyphe is noticeable in the adult, though it is very conspicuous in the larva; and also that in the adult only six (lateral and ventral) mesenteries bear generative organs; these correspond to the above-mentioned larval mesenteries. For the present we may assert that, although the adult *Halcampa* closely resembles the ordinary Actiniæ in the ratio of its tentacles and the disposition of its mesenteries, the larval form is undoubtedly more nearly allied to the *Edwardsiæ*.

Porifera.

Synocils, Sensory Organs of Sponges.†—Dr. R. v. Lendenfeld refers to a remark made in this Journal on the occasion of our reporting his account

* Proc. R. Dublin Soc., v. (1887) pp. 473–81 (1 pl.).
† Zool. Anzeig., x. (1887) pp. 142–5.

of a discovery of a nervous system in sponges; we drew attention to his apparent ignorance of a demonstration made at a meeting of the Society by Prof. C. Stewart. Prof. Stewart's discovery was published, with an illustrative figure, on p. 431 of Prof. Bell's 'Comparative Anatomy and Physiology' * (1885). This figure showed Dr. v. Lendenfeld that Stewart's sensory cells were different from those described by himself, and by the kindness of the latter he has been enabled to examine the original specimens.

He describes very long and large conical processes as arising everywhere on the surface of the sponge, and as having a widened basal piece; they are almost 0·1 mm. long, and about 0·016 mm. broad at their base; they are especially numerous at the entrance to the interradial currents. As neither F. E. Schulze nor Häckel have observed these structures in living Sycandræ, and as Dr. v. Lendenfeld has never seen them, he suggests that they are ordinarily retracted, and are only to be found extended under specially favourable conditions.

The processes consist of a substance which is identical with mesodermal intercellular substance, and are, apparently, invested by tubular epithelium; just below the broadened base there are several oval nuclei, surrounded by somewhat irregular plasmatic investments, and continued as a fine filament to the tip of the conical "palpocil"; Stewart's figure shows only one cell in each palpocil. If the process be withdrawn we get a group of cells very similar to the pyriform sensory cells already figured by von Lendenfeld.

The author concludes that in certain sponges there are special sensory organs which cannot be compared with what are found in Cœlenterates or Cœlomata; they may be called synocils in opposition to the simple palpocils. They probably represent a higher grade of development of the ordinary palpocil with its proper sensory cell, and perhaps owe their origin to the fusion of several simple palpocils, and the surrounding of the group with a proportionately well-developed layer of mesodermal intercellular substance; they are of mesodermal and not endodermal origin. The pyriform cells, which unite to form the synocil, are homologous and analogous with the spindle-shaped sensory cells of other sponges.

Position of the Ampullaceous Sac and Function of the Water-canal-system in Spongida.†—Mr. H. J. Carter endeavours to show that the pores in a sponge are as much for the general circulation and respiratory function as for the introduction of nutriment, and that the ampullaceous sac [or flagellated chamber], being situated on the surface of the excretory canals, only requires a single aperture to fulfil its function. He finds new evidence to support this view in a new species of South Australian sponge, which he calls *Wilsonella echinonematissima.* At the same time he does not doubt that in many instances there is more than one aperture in the sacs, but states that there is probably an equal number in which there is only one that serves the two purposes of inception of nutrient particles and exit of unassimilated material. The new species of sponge is remarkable as having the body-fibre of the Echinonematous type, and the terminal part that of a Psammonematous sponge; the sacs are sharply defined, persistent, comparatively scanty, and unusually tough under manipulation, so as to render the species excellent for observations on these structures.

* Which Dr. v. Lendenfeld quotes as 'Bell's Text-book of Zoology,' London, 1886, p. 144.

† Ann. and Mag. Nat. Hist., xix. (1887) pp. 203–12.

Observations on Fresh-water Sponges.*—Dr. A. Wierzejski has some various notes on fresh-water sponges. He thinks that Herr Noll is wrong in his account of the development of gemmulæ-balls of *Spongia fragilis;* they do not develope from extraordinarily large rudiments by division within the cellular cortical layer, but from special rudiments which the author has already described.

With reference to Dr. Vejdovsky's limitation of the hitherto known Spongillidæ to eight species, pleas are put forward against *Euspongilla rhenana* Retzer, and in favour of *Ephydatia mülleri* for which he thinks a special place ought to be found.

Protozoa.

Reticulated Structure of Protozoa.†—M. J. Kunstler calls attention to a communication of his in 1881 in which he describes the structure of protoplasm as alveolar. Without excluding strictly reticulated structure, numerous observations go to show that vacuolar or alveolar is in many cases the more accurate description. He notes the various modifications of these alveoli.

In *Dumontia apheliarum* the vacuolar elements are aggregated in a continuous mass, and do not separate into secondary groups. The small peripheral alveoli which are not disposed in very regular layers, enlarge towards the interior, and form a network with polygonal meshes. An areolar structure of a similar character is seen in the internal protoplasm of some Gregarines. The vacuoles contain fine granules. The circulating food-vacuoles are then discussed. According to the author they are surrounded by a proteid layer, formed at the mouth, and constituting transitory but coherent stomachs. In the Cryptomonads these are replaced by a permanent cul-de-sac. Even the flagella exhibit an alveolar structure.

Reticular Structure of Protoplasm of Infusoria.‡—M. Fabre-Domergue recommends the following method of demonstrating the fine reticulation of the protoplasm of *Paramæcium*, *Vorticella*, and other infusorians. They are fixed by a weak solution of iodine, washed with 10 per cent. solution of potash, and then with distilled water; a drop of very dilute acetic acid is afterwards added. After coloration with eosin the protoplasmic trabeculæ are seen with the greatest distinctness. They are very loose at the centre of the body, but more close in the ectosarc, where, as in *Opalina*, *Paramæcium* is vacuolated. The viscosity of the protoplasm is shown to be in relation to the condensation of the reticulum. This last represents the fixed part of the protoplasm, and it is by the differentiation of its substance at a given point that the contractile vesicle is formed. The passage of food along a straight line in *Didinium nasutum* is likewise due to the physiological differentiation of this reticulum. A distinction must be made between infusorians in which there is a structural peripheral reticulum and those which possess in addition an isolable cuticular membrane. This latter must not be confounded under the generic term of integument; the Oxytrichidæ, notwithstanding their cuirass-like ectoplasm, are really naked Infusoria.

Multiplication of Ciliated Infusorians.§—According to M. E. Maupas (*a*) the reproductive power of Ciliata depends on (1) the quality and quantity of food, (2) the temperature, and (3) the alimentary adaptation of

* Zool. Anzeig., x. (1887) pp. 122–6.
† Comptes Rendus, civ. (1887) pp. 1009–11.
‡ Ibid., pp. 797–9. § Ibid., pp. 1006–8.

the buccal organ. (*b*) Herbivorous, carnivorous, and omnivorous forms occur. *Cryptochilum*, *Paramæcium*, *Colpoda*, *Tillina*, *Colpidium*, and *Vorticella* feed on schizomycetes and small zoospores, thus purifying the water from Bacteria, Vibriones, Bacilli, and other microbes. *Stentor*, *Euplotes*, many *Oxytrichas* are omnivorous, while *Euchelys*, *Didinium*, *Lacrymaria*, *Leucophra*, *Trachelidæ*, and *Coleps* are carnivorous, though not despising zooglœa. (*c*) The herbivorous population is followed by the carnivorous with approximate regularity. *Coleps hirtus* can in a few days clear off a dense population of herbivorous forms.

(*d*) M. Maupas has carefully studied the reproductive powers of *Stylonychia pustulata* throughout many generations. In favourable nutritive conditions this species divides once in 24 hours with a temperature of 7°–10° C., twice at 10°–15°, 3 at 15°–20°, 4 times at 20°–24°, and 5 times at 24°–27°. At a temperature of 25°–26° C. a single *Stylonychia* would in 4 days have a progeny of a million, in 6 days of a billion, in 7½ days of a hundred billion. In 6 days the race would weigh 1 kg., and in 7½ days 100 kg. (*e*) With a vegetarian diet, however, the rate of reproduction is much less, and the size smaller. (*f*) Light seemed to have no influence on the development. Statistics are given for a large number of forms.

Protozoa of Marseilles.*—MM. P. Gourret and P. Roeser give an account of the Protozoa found by them in the old port at Marseilles; of the fifty-eight species which they enumerate twenty are new, and there are also some new varieties; they divide the localities examined into twenty, and point out that, where the waters are almost normal in character, there are both few species and few individuals as compared with stations where the water is putrid; among the stations of putrid water it seems that the number of forms increases with the foulness of the water, though there are, of course, limitations to this.

(1) *The Holotrichous Infusoria.*—*Paramæcium pyriforme* is a new species, varying in size, pyriform in shape, and with the mouth placed at the bottom of a groove which passes obliquely from right to left; there is a pharyngeal swelling, infundibular in shape, and continued into a short narrow cylindrical tube, which opens freely into the endocyte or central protoplasm. It is not possible to distinguish the oral cilia from the ordinary cilia of the cuticle; trichocysts do not seem to be present. The anterior contractile vacuole appears to be, and the posterior not to be constant; micrococci may often be seen in the clear parenchyma. This new species seems to be most nearly allied to *P. chrysalis* var. *viridis*. *Placus striatus*, first found by Cohn near Breslau, and *Nassula flava* are next described; of the latter *Chilodon ornatus* and *N. aurea* appear to be synonyms. *Enchelyodon striatus* sp. n. is flask-shaped, with a short neck, and a slight anterior swelling at the top of which the mouth opens. It moves very slowly, but its neck is very mobile and extensile; the cuticle is marked by two sets of striæ, one longitudinal and one transverse; the covering cilia are very short, but around the mouth the cilia are longer and more vigorous; the contractile vesicle is irregular in form and very large; this species seems to be nearest to *E. elongatus*. A new variety of *Metacystis truncula* is described, and is called variety *crassa*. The next three forms noticed are *Trachelocerca phœnicopterus*, *Lacrymaria coronata*, and *Chœnia teres*; of *Amphileptus* there are two new species—*A. lacazei* and *A. massiliensis*; the former is provided with special long vibratile cilia, in addition to others arranged in tufts; these are separated from one another, and are ordinarily placed in the interspaces between the tufts; they appear to be specially useful in move-

* Arch. Zool. Expér. et Gén., iv. (1886) pp. 443–534 (8 pls.).

ment. Longer and more compactly arranged cilia are found in the region of the mouth, and seem to have their function limited to producing an alimentary current. *A. lacazei* seems to be most nearly allied to *A. margaritifer*, and to have some resemblance to *A. cygnus*. *A. massiliensis* varies in size, and moves not only by the aid of its cilia, but also by the successive contraction and dilatation of the whole mass; sometimes it may be seen to twist on itself. *Loxophyllum pyriforme* sp. n. has a great power of contraction, and is incessantly changing its form; the cilia do not appear to be regularly distributed, though the trichocysts, which are found all over the body, are so; the endoplast appears to consist of two oval nuclei, of some size, very granular, and without nucleoli. *Lembadion ovale*, another new species, differs from the only species of the genus yet definitely described by having only one caudal seta, by the elongated form of its buccal pit, the elongation of its vibratile membrane, and other characters. After an account of *Plagiopyla nasuta* var. *marina*, and *Cyclidium glaucoma*, *Lembus intermedius* is described; it is very agile and extensile, but, on the least pressure, divides into two, a little behind the mouth.

(2) *Heterotrichous Infusoria.*—*Metopus sigmoides* is recorded, and a long account is given of *Condylostoma patens*, as to which previous writers have been in some disagreement, and a revised synonymy of the species is offered.

(3) *Peritrichous Infusoria.*—*Mesodinium pulex*, and *Gyrocoris oxyura* are described, as well as *Vorticella nebulifera;* of this last genus there are also two new species: *V. plicata*, distinguished by its longitudinal folds, and *V. anomala* which is remarkable for the delicacy of its anterior end, and the elongate cylindrical form of its pharynx; the contractile vesicle is very large; the stalk differs from that of most members of the genus in being contractile in its anterior half only; this is made up of a fine unornamented cuticle, a hyaline peripheral zone, a thick contractile sarcolemma, and a slender central cylinder. The lower half of the stalk has the cuticle thicker; this new form is interesting as being intermediate between the Vorticellidæ with a contractile, and those with a rigid peduncle. It is very rare. Of *Zoothamnium* two species were found, of which *Z. alternans* was described by Claparède and Lachmann, and *Z. plicatum*, which is new, and is distinguished from *Z. marinum* by having the stalk jointed, and by the possession of longitudinal striæ on the cuticle. *Epistylis barbata* is a new and very common species; it is perfectly smooth externally, and has an elevated vibratile disc; it contains parasitic cysts of, apparently, an *Opalina;* this small infusorian introduces itself by the peristome, and passes into the parenchyma, living at the expense of its host which it completely destroys. When set free the cyst swims about rapidly and undergoes a number of modifications. *Cothurnia fusiformis* sp. n. is very closely allied to *C. nodosa; C. striata* sp. n. differs from *C. pusilla* by the size of the body, the presence of cuticular annellations, the absence of an operculum, and the shortness of the peduncle.

(4) *Hypotrichous Infusoria.—Chilodon complanatus* sp. n. is continually changing its form, and has a distinct ventral surface very different from the dorsal; the mouth is large, the pharynx short, conical, and provided with chitinous rods, which form a framework for it; it has no vibratile lip, as in *C. cucullulus*, in the company of which it is found living. *Ægyria angustata* with a variety, *ovalis*, is next described; *Æ. marioni* is a new species, and is marked by the reduction of the frontal and ventral cilia, the presence of a spiny crest on the left valve, the longitudinal striæ in the dorsal region, and the form of its swallowing apparatus. *Æ. monostyla*, *Æ. fluviatilis* (var. n. *marina*), *Aspidisca polystyla* (var. n. *maxima*) are next noticed;

Aspidisca bipartita is a new species remarkable for the absence of hook-like appendages, and the apparent conversion of the posterior stylets into cirri or cilia. *Glaucoma pyriformis* and *Euplotes Charon* are followed by the description of *E. gabrieli* sp. n.; this is distinguished from *E. longipes* by the presence of a frontal tooth, the length of the frontal cirri, and other characters, and from *E. harpa* by the absence of longitudinal striæ, the size of the posterior stylets and frontal cirri, and the form of its nucleus, which is a large spherical mass.

(5) *Flagellate Infusoria.*—*Cercomonas crassicauda*, *C. longicauda*, *Polytoma uvella*, *Oxyrrhis marina*, *Sphærophrya pusilla* (with which *S. sol*, *S. paramæciorum*, *S. urostylæ*, and *S. magna* are united) are next noticed; *S. massiliensis* is a new species in which it is interesting to study the phenomena of division; in it, and probably in other species of the genus, there is an external limiting membrane, which takes a share in the fission; this membrane is identical with that of the Acinetæ. After a short account of *Acineta fœtida*, *A. contorta* and *A. parroceli* complete the paper; these last are both new species, the former is large, and both it and *A. parroceli* somewhat recall *A. crenata;* they are both very remarkable in the fact that the orifice of the test, though wide, is very narrow in proportion to the dimensions; the arrangement of the tentacles in *A. contorta* is normal, but in *A. parroceli* these appendages are more like those of *Podophrya elongata* where they are ranged along the body; they are very fine, short, and comparatively numerous. *A. contorta* feeds on *Euplotes.*

New Protozoa.*—Mr. W. Milne describes and figures a new form, belonging to the Tentaculifera, to which he gives the name *Stylostoma Forrestii* nov. gen. et sp. It is marine, and was attached to a *Cyclops.* The new genus is founded on the fact that the capitate tentacles do not spring directly from the body, but arise in groups at the extremities of three arms. Vermiform zooids are described, but were not traced to the adult form.

A new species of *Strombidinopsis* is described, to which the specific name *proboscidifer* is given. The truncate end carries numerous "tentacle-like cilia, finely feathered with minute cilia all round their whole length." Inside this ring is a membranous collar, and within this is a protrusible proboscis. The author compares the ring of cilia to the membrane of *Torquatella*, and shows how it could be derived from the latter. A peculiar method of reproduction is noted. A new species of *Oxytricha* is described as *O. tricornis.* Both these forms are marine. Some observations are made on *Ophridium sessile* S. Kent and *Amphisia multiseta* Sterki, and of the latter certain doubtful stages in development are described.

New Fresh-water Infusoria.†—Dr. A. C. Stokes gives definitions of a number of new genera and species of fresh-water infusorians. *Trentonia* (*T. flagellata* sp. n.) is allied to *Raphidomonas;* one flagellum is trailing and one vibratile, and the frontal border is slightly bilabiate; no trichocysts were observed; the trailing flagellum is best seen when the creature is rendered uncomfortable and sluggish by prolonged confinement beneath the cover, or partially poisoned by iodine; the author suggests that *Raphidomonas semen* may have two flagella; if not, *T. flagellata* will form the type of a new family of *Trentoni*[*i*]*dæ*. *Cyclonexis* is a new genus which differs from *Uvella* in the lateral instead of the posterior union of the constituent animalcules, in the annular rather than spheroidal form of the colony, and in the very diverse length of the two flagella. *C. annularis* sp. n. was found with *Sphagnum.*

* Proc. Phil. Soc. Glasgow, 1886, 8 pp. (1 pl.).
† Proc. Amer. Phil. Soc., 1886, pp. 562–8 (1 pl.).

Opisthostyla is a new genus, the constituents of the colonies of which resemble those of *Rhabdostyla*, "but the rigid pedicel curved near its point of attachment to the submerged object, this part acting when the zooid is contracted like a spring, and throwing the animalcule and the otherwise inflexible footstalk backward through the water, the whole immediately becoming upright by the recoil of the curved extremity of the pedicel." *O. annulata* is a new species, and *Rhabdostyla pusilla*, described by the author in 1886, clearly belongs to this genus. *Acinetactis mirabilis* g. et sp. n. differs from *Actinomonas* by having two flagella, and by the distinctly capitate character of the filamentous pseudopodia, which are often conspicuously pin-like in appearance. The flagellum may be temporarily adherent, and its pressure in addition to the habitually vibratile appendage necessitates the formation of a new family which may be called Acinetactidæ.

The other new species described are *Mastigamœba longifilum*, *Anisonema pusilla*, *Cryptoglena truncata*, *Pyxidium urceolatum*, *Rhabdostyla invaginata*, in which the ciliary disc has a characteristic conical form, *Colpoda depressa*, in which the oral aperture is on the flattened ventral surface, *Metopides acuminata*, *Trichophrya sinuosa*, which is much smaller than *T. epistylidis*, *Acineta lacustris*, which was found attached to *Anacharis*, and *A. stagnatilis*, which was found on *Myriophyllum*.

New Hypotrichous Infusoria.*—Dr. A. C. Stokes describes a new genus of Hypotrichous Infusoria, for which he proposes the name of *Hemicycliostyla*; the forms are free-swimming, have twenty or more frontal styles, arranged in two more or less semicircular rows, no anal styles, contractile vesicles single or double, nucleus multiple; *H. sphagni* sp. n. is 1/50 to 1/60 in. long, one-fourth as broad, anal aperture dorsal, parenchyma vacuolar, adoral cilia short. An allied form is distinguished by having only one contractile vesicle, the absence of vacuolar spaces, and the development of a conspicuous series of par-oral cilia on the inner edge of the left-hand border of the peristome field; it may be called *H. trichota* sp. n.

Urostyla gigas is a giant among Infusoria, having, when extended, the length of 1/30 in.; like the preceding species, it was found with *Sphagnum*. There are from forty to sixty nuclei, which, if they have a connecting thread, must have a very frail one, as the nuclear nodules float out freely and separately from the disintegrated dead body. *U. caudata* sp. n. is an ally. Three new species of *Holosticha*—*H. caudata*, *H. hymenophora*, and *H. similis*—are described; as yet only one fresh-water species has been recorded. The new form will require an emendation of the generic definition, as the peristomial membrane, the increased number of frontal styles (five in *H. hymenophora* and about fourteen in *H. similis*), and the double contractile vesicle of the former, have not yet been noticed; *H. similis* is alone known to have a moniliform vesicle. In *Uroleptus dispar* sp. n. the difference in the size of the ventral setæ of the two median rows is unusually well marked; there is in it that prolongation of the anterior end as a narrow crescent which is often seen in Infusoria, and which is usually styled the upper lip; Dr. Stokes believes that it is a continuation of the ventral plane, and that it ought therefore to be called the lower lip. *U. longicaudatus* sp. n., also found with *Sphagnum*, is unusually active, and is very flexible and elastic.

Eschaneustyla g. n. most nearly approaches *Urostyla*; it has the ventral setæ in three unequal longitudinal lines; it is remarkable for having a spherical pulsating vacuole, with canal-like diverticula, somewhat resem-

* Proc. Amer. Phil. Soc., 1886, pp. 21–30 (1 pl.).

bling that of *Stentor*; *E. brachytona* is the new species. *Platytrichotus* is a new genus (*P. opisthobolus* sp. n.) which appears to connect *Holosticha* and *Uroleptus*; its caudal appendage is not constant, but changeable in form and extent; in addition to the immobile dorsal hairs there are three long flattened setæ, which are voluntarily vibratile.

Leucophrys patula.* — M. E. Maupas offers some remarks on the strictures lately made by M. Balbiani † on his account of the development of this infusorian. He states that he was well acquainted with the results of previous observers, and he gives what he thinks is a complete list of Ciliata which multiply after encystation in the way described by him. What was seen in *Leucophrys* was, however, essentially different; there is in their history no encystation—what happens is this, so long as there is abundance of food, fission obtains; when food grows scanty there is metamorphosis without encystation, followed by six successive divisions. While this is the morphological difference, the physiological one is no less important—the divisions are effected without vegetative growth, and have for their final object not multiplication but conjugation. With regard to the fecundity of the *Ichthyophthirius* cited by M. Balbiani the author accepts the number of a thousand individuals in three days, but he points out that *Leucophrys* at a temperature of 20° C. in a richly nutritious medium would give rise to 16,384 individuals in three days; suppress the food and in a few hours this large number would be multiplied by 64; there would be a total of 1,048,576 individuals, or more than a thousand times the number of *Ichthyophthirius*.

New Genus of Parasitic Infusoria.‡—Prof. M. Braun has a note on a new genus of parasitic infusorians lately described by Herr Lindner, and examined also by Prof. Bütschli; it is a peritrichous form first found at Cassel in water containing organic débris; it was afterwards observed in drain water from houses and cattle-stalls; it lives in the cæcal contents of the pig, and in the fæces of typhus-patients, and even in urine. When these waters are first examined the creature is not seen, but ordinarily appears in from five to eight days. Although it has no stalk Prof. Bütschli places this infusorian with the Vorticellidæ. If its food dries up several individuals unite and become encapsuled; they multiply by longitudinal division, and that with great rapidity in suitable fluids.

It is proposed to call this new form *Ascobium*, though it is supposed to be derived from *Vorticella microstoma*, which has gradually lost its stalk from the change in its food; Prof. Braun thinks it ought not to be regarded even as a new species, but merely as the separated capitulum of a form already known.

Parasitic Protozoa in Ciona intestinalis.§—Dr. C. Parona continues his description of parasites found in the alimentary tract of *Ciona*.

In addition to that described in a previous communication ‖ a new genus is formed, which has affinities both to *Dallingeria* and *Trimastix*, to which the name of *Elvirea* is given.

The new genus has an oval body, rounded anteriorly and posteriorly. Three flagella are carried anteriorly, of which the middle one is the shortest, only one of these is used at a time; the other two are carried behind, or twisted round the body; each of the three is used alternately.

* Comptes Rendus, civ. (1887) pp. 308–10.
† See this Journal, *ante*, p. 253.
‡ Centralbl. f. Bacteriol. u. Parisitenkunde, i. (1887) pp. 204–5.
§ Journ. de Microgr., xi. (1887) pp. 25–8.
‖ See this Journal, 1886, p. 106.

The nucleus and nucleolus are situated in the middle of the anterior part of the body.

The differences from the above genera are exhibited in the following table:—

Trimastigidæ (3 flagella)	All three active	.. ..	*Callodictyon.*
	Two active, one training	.. ..	*Trichomonas.*
	One active, two training	Animal free or fixed	*Dallingeria.*
		Animal always free, and without undulating membrane	*Elvirea* (nov. gen.)
		Animal free, but with undulating membrane	*Trimastix.*

The author considers that of these *Callodictyon* is the lowest, and that a gradual differentiation can be traced through the other forms to *Elviria*, which is always free; and this is more perfect than *Trimastix*, since the latter possesses a membrane. The third parasite dealt with is also probably new to science, but the author leaves it undetermined at present, since only one specimen was noted. This is a Ciliate Infusorian, elongated, attenuated in front, enlarged behind. It is transparent, highly retracting, and slightly granular; there are four or five non-contractile vacuoles in centre, and three in posterior of body. Nucleus anteriorly. The sides, and posterior parts of body are deprived of cilia, and these are very short; anteriorly the cilia are strong and stout.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.*

(1) Cell-structure and Protoplasm.

Protoplasm.†—In a report of very elaborate researches on the nature of protoplasm, Dr. G. Berthold maintains the old view that it is to be regarded as a highly complex emulsion, differing in consistence in the different cases; and that the forces upon which the changes of form, internal movements, and so forth, depend, are the same as those which determine whether a fluid shall assume the form of a drop, or drops, or spread out and wet another body, and so on—in fact, the forces concerned in surface-tensions.

To take an example of a typical cell:—a spore of *Equisetum* may be regarded as a system of concentric layers. First there is a central nucleus; then various layers of protoplasm, of which the innermost is colourless and contains certain minute granules, the second is thicker and carries the chlorophyll-corpuscles, the third is hyaline, and contains lenticular refractive bodies of peculiar nature; then follows the cell-wall, if nothing further. The cell-wall is usually composed of three or more layers. If we consider the cells of a tissue, Berthold points out that a given partition membrane must be regarded as dividing and belonging to two symmetrical plasmatic systems, and as being their middle and innermost layer.

But all cells are not systems of concentric layers. Not only are

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Berthold, G., 'Studien über Protoplasmamechanik,' Leipzig, 1886. See Prof. H. Marshall Ward in Nature, xxxv. (1887) p. 300.

excentric layers found, but a complexity is introduced as soon as the sap-vacuoles appear, in many cases making the cell not monocentric but polycentric. The *normal* order of the layers, as exemplified by the spore of *Equisetum*, or any simple cell with one large vacuole, &c., may be distinguished from the *inverse* order exhibited, for instance, by the cords in a *Caulerpa*, or the central mass in a cell containing raphides, or anywhere where the sap bathes the system of layers referred to.

It is then shown that in many cases where oil-drops, &c., have usually been regarded as lying free in a cell, they are inclosed in an ingrowth from the cell-wall, reminding us of cystoliths. An examination of intercellular spaces follows: the most interesting question is as to the existence of protoplasm in lacunæ between cells. Berthold goes much further in this respect than other writers. He finds a thin layer of protoplasm overlying the cuticle of the epidermis and of spores, and concludes that the cell-wall is formed and imbedded in protoplasm, and not excreted on its surface—the cell-wall is a supporting apparatus, not a protective one. Again, a cell forming part of a tissue cannot be forthwith compared with a unicellular alga, for this reason: the latter may be regarded as consisting of two parts, (1) the inner protoplasmic system with its contiguous share of cell-wall, (2) the outer strata of cell-wall *plus* the hypothetical covering of protoplasm. Only the first of these two parts of the algal cell can be compared with a tissue-cell.

The second chapter is concerned with the finer structure of the cell-nucleus, chlorophyll-corpuscles, and other cell-contents. It is stated that starch is not formed in the Melanophyceæ, and that the word "microsome" has no definite meaning, and had better be discarded.

If protoplasm is an emulsion, it follows that the various processes of separation of sap-vacuoles, oil-drops, crystalline and other particles, have to be explained as according with similar separations in lifeless mixtures; and this the author maintains to be the case.

The supposition that anything is explained by regarding protoplasm as essentially "living proteid," is severely criticized, and the author agrees with Baumann that the arguments which exalt proteids into the position of being the most essential constituent of protoplasm would apply equally well to water. The "living substance of organisms" is always an extremely complex mixture. Berthold proposes to recast the definition of protoplasm, and to subordinate to it—the fluid mixture absent from no living cell—cytoplasm, nucleus, chlorophyll-bodies, vacuoles, tannin and oil-drops, &c., as so many parts of the protoplasm as a whole.

In the third chapter is an analysis of the movements of naked masses of protoplasm. All turns upon the tendency of a mass of protoplasm to assume the form of a spherical drop; this can only be due to the same causes which impel a drop of any accepted liquid to assume the drop condition. The amœboid condition depends upon the degree of wetting of the environment by the fluid protoplasm, and *vice versâ*. If three fluids which do not mix are in contact with one another, the tensions at their surfaces can be mathematically investigated, and Berthold maintains that the principles here concerned govern the behaviour of a drop of protoplasm as they do that of an ordinary liquid under the given conditions. The phenomena of spreading out, putting forth and withdrawing pseudopodia, rounding off, &c., are due to the same causes and ruled by the same laws as the flowing of one liquid over another, or its withdrawal from it (glycerin and alcohol, for example), or its assumption of the drop form, and so on.

The fourth chapter deals with the symmetry or arrangement of the cell-contents. The stratified or shell arrangement is again expressly referred to,

and an attempt made to explain it on the main assumption of the book. The arrangement referred to is a consequence of exchanges (diffusion, absorption, &c.) with the environment: passive particles suspended in the cell would have to assume positions which are definite; active particles (i. e. particles which themselves exchange with the layer in which they are imbedded) might interfere with the simple shell arrangement, and we have systems within a system. After examining what occurs in the case of a spherical system or cell, the author extends the analysis to an ellipsoid and other anisodiametric systems, and finds the results accord with what is found in nature. The question of the "Hautschicht" is then attacked, and De Vries' late statements as to the existence of a pellicle or "wall" around the vacuole are criticized. Berthold condemns this pellicle as an artificial product—a "precipitation-membrane"—in many if not in most cases.

The fifth chapter is concerned with showing that, in spite of the great variety of forms exhibited by the chlorophyll-bodies of different plants, especially Algæ, their position, consistence, changes in form, division, &c., can be explained in accordance with the view that they are parts of an emulsion. Other cell-contents are considered also, oil-drops, tannin, nucleus, vacuoles, &c. The chlorophyll-corpuscles of higher plants are compared to drops resting on a substratum which they do not wet, their shape being in part due to radial pressures.

The division of chlorophyll-corpuscles is then examined, and this leads to the division of the nucleus and cell, which is treated separately. A spherical mass of fluid must increase its surface if it divides; this implies a diminution of tension at the common surface (as with the formation of pseudopodia), and concentric shells in the medium or in the mass of fluid in question. All the conditions fulfilled, pseudopodia can be formed either from the medium into the mass, or from the mass into the medium. An annular pseudopodium would divide the spherical (or spheroidal) mass into two.

This leads to the sixth chapter, where, after reviewing the process of cell-division generally, the author separates the essential from the unessential processes, and agrees with Strasburger that the division of the nucleus must be regarded as an accompanying phenomenon. The division of the ovum of *Echinus* and *Ciona* is described: soon after the male and female nuclei have fused, two centres appear in the egg, each with radii—the required bi-polarity is established. The exchanges and movements in the protoplasm are then followed; the result is that certain constituents accumulate to excess in the equator between the two radiating centres, or "suns." The two "suns" are the centres of the future daughter-cells; the still single nucleus lies between them in a bridge of the same protoplasm as that in which the "suns" are imbedded: the more peripheral protoplasm of the cell (ovum) has accumulated chiefly round the nucleus—i. e. in the equatorial plane. This equatorial protoplasm then begins to cut in two the nucleus, which has assumed the "karyokinetic" condition. The superficial shells of protoplasm are assumed to put forth pseudopodia between the "suns"—i. e. the author regards it as fundamentally a wetting process, due to changes at the surfaces; the processes are essentially of the same nature in vegetable cells.

The seventh chapter treats of the cell-network of plants, and the directions of cell-divisions, &c. It is in great measure a criticism of Sachs's view of the structure of the higher plants. Two main principles are employed. (1) The cell-divisions are, as a rule (at least in growing-points, &c.), halvings—i. e. each daughter-cell has the same cubic contents. The shape

of a segment does not forthwith enable us to judge of its relative contents, and difficulty occurs sometimes on this account. (2) The second fundamental principle is that which regulates the position of fluid lamellæ elsewhere—the principle of least areas. The rule is that the new cell-wall takes such a direction that its area is the smallest possible. There are exceptions, e. g. cambium cells; but at least one feature appears to indicate a tendency to follow the principle—cell-walls never abut in the angles of cells. Sachs's law of rectangular division is comprehended as a particular case of Berthold's more general law: it fails where simultaneous divisions result in the formation of polygonal cells—e. g. in the embryo-sac—with walls inclined at angles greater than the right-angle.

The eighth chapter deals with the sculpturing on the interior of cell-walls, and allied phenomena; while the ninth chapter is devoted to "free-cell-formation."

Chemical reactions of Protoplasm.*—By the use of a number of chemical reagents, the application of which is specified—all of which dissolve some of the proteinaceous constituents of the cell, leaving others undissolved—Herr F. Schwarz determines the distinctiveness of the following substances, viz.—In the nucleus a ground-substance, fibrillar substance, chromatin, nucleoli, and membrane. In the chlorophyll-grains a fibrillar substance capable of swelling but never soluble, and an intermediate substance capable of both, but never a chemically differentiated membrane. In the cytoplasm a fibrillar and an intermediate substance, together with imbedded granules; no chemical differentiation of the outer and inner boundary of the cytoplasm could be determined.

(2) Other Cell-contents.

Starch in Vessels.—In corroboration of previous observations, Herr A. Fischer finds,† in fully 80 per cent. of the leaf-stalks of *Plantago major*, starch-grains in some of the vessels and tracheids; and the same was the case also with several other species of the same genus. The starch-containing tracheids are sometimes the oldest spiral vessels in the vascular bundle of the leaf-stalk, sometimes the last-formed dotted vessels; each bundle may contain one or more of these tracheids; the quantity of starch varies from a few grains to a sufficient amount completely to fill up the vessel, which always has a well-developed lignified wall. The starch-containing tracheids sometimes lie in a row one behind another, but do not extend through the whole of the leaf-stalk. By maceration and staining with anilin-blue, the author was able to determine the invariable presence of protoplasm in these tracheids, sometimes also of a nucleus. No starch-producers could be detected.

In confirmation of these observations, Herr J. Schrenk ‡ states that he finds abundance of starch in vessels in the haustoria of *Gerardia* and in the rhizome of *Aristolochia serpentaria*. In these cases it occurs, not in spiral vessels, but in vessels with bordered pits, and Herr Schrenk believes that the starch was originally produced in thyllæ.

Starch and Leucites.§—According to M. E. Belzung, grains of chlorophyll are of two different kinds, according to their origin. *Chloroleucites*, with an albuminoid skeleton, resulting from differentiation of the protoplasm,

* Ber. Deutsch. Bot. Gesell, iv. (1886) Gen.-Versamml., pp. ciii.–cviii.
† Ibid., pp. xcvii.–cii. Cf. this Journal, 1885, p. 671.
‡ Bot. Ztg., xlv. (1887) pp. 152–3.
§ Bull. Soc. Bot. France, viii. (1886) pp. 483–4. Cf. this Journal, 1886, p. 819.

and *chloroamylites*, with a ternary skeleton, originating from starch-grains. In the latter case the protoplasm of the cell takes no part in the production of the chlorophyll-grains. Starch is, however, necessary for the formation of the skeleton of both chloroleucites and chloroamylites, and for the development of the chlorophyll-pigment. When starch is wanting, chloroamylites lose their green colour and finally disappear; they are usually of a temporary character, while chloroleucites may remain during the whole life of the plant.

Composition of the Starch-grain.*—M. E. Bourquelot has made a number of observations on the chemical constitution of starch-grains, which result in the view that they are not composed of only one or two chemical bodies (granulose and amylose), as has been hitherto supposed, but of a larger number of carbohydrates.

Starch-grains coloured red by iodine.—Herr A. Meyer finds,† in seventeen different species of plant belonging to seven different families, starch-grains which take a red colour with iodine. In *Goodyera discolor* they are compound. They were examined chiefly in the endosperm of Chinese and Japanese species of *Sorghum*. They do not differ in appearance from those which are coloured blue, but are much more readily broken up; they take a rather higher temperature to make them swell; and the black cross is more conspicuous with polarized light; they are more rapidly acted on by ferments. After treatment with acids they show a distinct lamination, and are coloured only a very faint red by iodine. From their various reactions, Meyer believes that the difference between these grains and those that are stained blue by iodine is that, in addition to "starch-substance,"‡ they contain amylodextrin, and a third substance which is not coloured by iodine, and is soluble in water, probably a dextrin. Those grains which take a violet colour with iodine contain traces of amylodextrin, and perhaps also of dextrin; those which are coloured red, only a small quantity of starch-substance. He believes them to be formed, by a kind of fermentation, from the "blue" grains.

Herr F. W. Dafert § contests several of the points insisted on by Meyer in this paper, and maintains, among others, that amylodextrin does not occur in potato-starch.

Soluble Starch.‖—Herr J. Kraus, having found, dissolved in the cell-sap of the epidermis of some *Arums*, a substance previously met with by Dufour and others in the epidermis of *Ornithogalum* and *Gagea*, has come to the conclusion that it is allied to the tannins. It gives a blue colour with iodine, chloriodide of zinc colours it rose, ferric chloride and ferrous sulphate give a brownish-green; on the other hand, potassium dichromate and Gardiner's reagent give no reactions. The substance behaves like a tannin in being developed under the influence of light, and in persisting without alteration in dead or dying leaves. That iodine should give a blue colour with tannin is not surprising, since Giessmayer has shown that a solution of tannin gives with a weak solution of iodine, in feebly alkaline water, a bright red colour, and, under certain conditions, according to Nasser, a red-purple.

* Comptes Rendus, civ. (1887) pp. 177–80.

† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 337–62 (1 pl. and 1 fig.).

‡ See this Journal, *ante*, p. 256.

§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 108–14.

‖ Ann. Agronom., xii. (1886) pp. 540–1. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 173. Cf. this Journal, 1886, p. 819.

Formation of Albuminoids in Plants.*—The following experiment, performed by Herr C. O. Müller, shows the conditions under which asparagin is formed in plants. If a portion of a plant is placed in darkness by enveloping it in black paper, while it still remains connected with the parent, and the older portions are left undisturbed, then an accumulation of asparagin is formed, which, when the light is admitted, is absorbed. This does not occur in the fully grown parts save exceptionally. This result seems to show that the formation of asparagin is independent of carbohydrates, and also that the amide formed is not a bye-product of the interchange of matter within the plant. It has also been found that even when a plant is growing under abnormal conditions when all carbon dioxide has been removed from the air, asparagin is formed in the young parts, but not in the matured portions. Consequently it appears as if light played as inconspicuous a part in the formation of asparagin as carbohydrates. The author considers that asparagin is formed by the union of inorganic nitrogen compounds and malic acid within the plant, the acid being derived from the carbohydrates.

Poulsen's Crystals.†—Sig. P. Calabrò has investigated the occurrence of these crystals in *Erythrina mitræfolia.* He finds them almost entirely absent from the root, most abundant in the stem. In the leaves there are fewer in the lamina than in the petiole. In the floral region they are few and very small. As to their constitution, the crystals consist for the greater part of pure cellulose, which, towards the base, has undergone a certain amount of lignification. The mineral constituent is calcium oxalate.

New nitrogenous constituent of the Lupin.‡—Herren E. Schulze and E. Steiger obtain, from an aqueous extract of the cotyledons of etiolated seedlings of lupin, by the addition of tannic acid and sugar of lead, acidulating with sulphuric acid, and decomposing by phosphoric-tungstic acid, a basic substance to which they give the name *arginine.* The nitrate presents the formula $C_6H_{14}N_4O_2HNO_3 + \frac{1}{2}H_2O$.

Production of Chlorophyll in an objective spectrum.§—By means of a normal objective solar spectrum, Herr J. Reinke found that the production of chlorophyll took place most rapidly on both sides of the line C, nearly in the interval $\lambda = 635$ to $\lambda = 675$; the curve falls from this maximum towards both ends of the visible spectrum. Positive heliotropism of seedlings is manifested even in the yellow when the light is sufficiently strong.

(3) Secretions.

Chemical composition of certain Nectars.‖—M. de Planta has made a complete chemical analysis of a certain number of nectars. The following is a *résumé* of the results. In the fresh nectar of *Bignonia radicans* the author found 14·84 per cent. of glucose and 0·43 per cent. of cane sugar; in the nectar evaporated to dryness, 97·0 per cent. of glucose and 2·85 per cent. of cane sugar. In the fresh nectar of *Protea mellifera* 17·06 per cent. of glucose was found, but no cane sugar; in the dry nectar

* Landw. Versuchs-Stat., 1886, pp. 326-35. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 70.
† Malpighia, i. (1886) pp. 169-75 (1 pl.).
‡ Ber. Deutsch. Chem. Gesell., xix. (1886). See Bot. Centralbl., xxix. (1887) p. 167.
§ Ber. Deutsch. Bot. Gesell., iv. (1886) Gen.-Versamml., p. cxix.
‖ Zeitschr. f. Physiol. Chem., x. p. 3. See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 212.

the percentage of glucose was 96·6. In the dry nectar of *Hoya carnosa* the percentage was 12·24 of glucose and 87·44 of cane sugar. The author states that nectar is destitute of formic acid, and that its composition varies considerably with the age of the nectariferous tissue.

(4) Structure of Tissues.

Thickening of the wall of parenchymatous cells.*—M. J. Baranetzki states the following general conclusions as the results of a study of this subject. The thickening of the soft parenchyma usually presents itself, in its mature state, in the form of a network composed of separate strings arranged in a definite manner. In the very young state of the cell-wall its thickening has always the form of a delicate network, subsequent transformation of which may produce a thickening in the form of punctations; the punctations of lignified cells have always the same origin. In the walls of parenchyma there may always be distinguished at least two, and often three superposed systems of thickening layers, characterized by special morphological peculiarities, viz. — *a*, primary membrane, altogether continuous and homogeneous; *b*, secondary thickening, having at first always the form of a network, but subsequently transformed into punctations; *c*, tertiary thickening, sometimes in the form of broad bands, sometimes of still continuous layers, which may then cover up the punctations of the secondary system.

The secondary and tertiary thickenings are produced by the successive apposition of new layers on the inner surface of the cell-wall. Those walls which have only a secondary thickening appear never to become lignified; lignification commences only with the formation of the tertiary layers, and depends on the fact that the protoplasm produces, along with cellulose, certain other soluble substances which impregnate the cell-wall. The direction of the strings of secondary thickening is determined by the general direction of growth and by the form of the wall. The secondary strings or bands are always adapted, by their form and arrangement, to protect the cell-wall in the best possible way against the pressure exercised in the plane of the cell-wall itself.

Endoderm of Senecio Cineraria.†—M. P. Vuillemin describes the structure of the endoderm of this species, which closely resembles that in *S. caudatus*. It originates, both in the stem and leaves, on the back of the fibrovascular bundles. The oleiferous canal is formed at the expense of a cell of the internal row. The outer row establishes the continuity of the amylaceous layer in the leaf and of the layer of cells with folded walls in the stem.

Cambium of the Medullary Rays.‡—On physiological grounds connected with the storage of food-materials, and with the function of the initial cells of the medullary rays, Herr A. Wieler contests Haberlandt's view,§ that the cambium of the medullary rays is a secondary meristem.

Pores of the Libriform Tissue.||—Dr. Emily L. Gregory describes the various kinds of pore found in woody tissue, distinguishing between those which are simple and those which are bordered. The principal genera of 67 families were examined, among which there were only 8 in which the libriform tissue contains both bordered and simple pores; 18

* Ann. Sci. Nat. (Bot.), iv. (1886) pp. 135–201.
† Bull. Soc. Bot. France, viii. (1886) pp. 538–40.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 259–66.
§ See this Journal, 1886, p. 1009.
|| Bull. Torrey Bot. Club, xiii. (1886) pp. 197–204, 233–44 (4 figs.).

contained only bordered, and 34 only simple pores; the remaining 7 varying in their different genera. The author considers it probable that there is a decided difference in function between simple and bordered pores, the latter having more especially for their object to facilitate the passage of water through the plant. With extremely few exceptions, when the libriform cells are used as reservoirs of starch, this substance is formed only in those with simple pores.

Albumen-vessels in the Cruciferæ and allied orders.* —Herr E. Heinricher finds the peculiar idioblasts already described by him in species belonging to 18 out of the 21 tribes of the order Cruciferæ. Their distribution in the various points of the plant differs in different species. In Capparideæ they were found in three species of *Capparis*, but not in *Cleome;* in the Papaveraceæ, in *Eschscholtzia;* in the Fumariaceæ, in *Adlumia* and *Corydalis.* The micro-chemical reactions showed the contents of these tubes to be always of an albuminoid character. The hypothesis that they are not simply reserve-organs, but that the proteids are formed in them, is rendered highly probable by the sharp localization of their contents, which are well differentiated from the protoplasm of the surrounding cells. They are apparently first formed at a very early period, their rudiments being visible even in the ripe cotyledons of the seeds of *Sinapis alba.* Phylogenetically the author adopts the view that they are derived from the segmented laticiferous vessels of the Papaveraceæ. In *Adlumia* and *Corydalis* these albumen-vessels are very long, and form a reticulation in the mesophyll of the leaf similar to the laticiferous vessels of *Euphorbia;* but they have blind endings.

Tannin-receptacles in the Fumariaceæ.†—Herr W. Zopf describes structures in the Fumariaceæ, which appear to correspond to the latex-tubes in the allied order Papaveraceæ. He finds them in all species examined of the genera *Corydalis*, *Adlumia*, *Dicentra*, and *Fumaria*, and in all parts both above and under ground. They take the form of idioblasts, very often of great length but undivided, containing a colourless, red, or yellow substance of the nature of tannin. They are either protogenous, formed in the primary meristem, or hysterogenous, developed in the cortex or cambium of the vascular bundles. In both cases they do not at first differ from the ordinary cells. No fusion of cells nor sieve-plate-structure was observed. A nucleus was in all cases detected, and in the longer idioblasts there are probably several.

These receptacles contain large quantities of tannin, either colourless or coloured by a yellow or red anthocyan, the latter especially in those parts which are exposed to strong light; and this is apparently the result of the action of vegetable acids. The yellow pigment is also formed in the course of development of the plant, and is preceded by a colourless substance or chromogen. There are probably a number of different anthocyans characteristic of different plants.

Formation of Cork in the Stem of plants with few or no leaves.‡— Herr H. Ross has investigated the structure of the stem in relation to the development of cork in a number of plants in which the stem is nearly or quite leafless. He finds that in such plants, where the stem is perennial, assimilating tissue is always formed in the outer cortex, and

* MT. Bot. Inst. Graz, i. (1886) pp. 1–92 (3 pls.). Cf. this Journal, 1885, p. 672.
† Biblioth. Bot., 1886, 42 pp. and 3 pls. See Bot. Centralbl., xxix. (1887) p. 39.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 362–9.

the formation of cork is usually retarded as long as possible. The periderm most often takes the form of longitudinal strips, formed in such a way as to disturb the assimilating tissue as little as possible. These strips often remain for some years; finally they coalesce, and then for the first time form an unbroken periderm, such as is developed during the first year in nearly all woody plants.

Anatomy of Menispermaceæ.*—M. R. Blottière describes the anatomical structure of typical species belonging to each tribe of this order. Its affinities he believes to be with the Lardizabaleæ. He proposes to classify the genera under five suborders, characterized by the nature of the fruit, whether drupaceous or baccate, by the number of ovules, whether one or many, and by the presence or absence of endosperm and of a laticiferous system.

Anatomy of the Stem of Orchideæ.†—Herr M. Möbius points out that in both their structure and arrangement the fibrovascular bundles in the stem of a large number of native (German) Orchideæ present a singular approach to those of Dicotyledons. The bundles are arranged in a single ring, in the uppermost portion of the stem, and show at least traces of an active cambium. The detailed structure is described in a number of different species, and it is shown that the chief differences are correlated with differences in the structure of the labellum and in other floral characters, the Ophrydeæ and the Neottieæ presenting two distinct types.

Structure and Geographical Distribution of Plumbagineæ.‡—M. P. Maury takes as his type of this order the genus *Plumbago*. The primary structure of the internal part of the root is as follows:—Inside the endoderm one or more layers of cells constitute the rhizogenous layer, enveloping the central cylinder, formed of four woody bundles in the shape of a cross, alternating with which are four liber-bundles. In the young stem the author recognizes (1) the epidermis, (2) a cortical zone of eight or ten layers of cells, (3) the endoderm, (4) the zone of liber, (5) the central cylinder formed of eight fibrovascular bundles, separated by large medullary rays, and leaving a large portion of pith in the centre. On the stems and leaves of Plumbagineæ are frequently numerous small masses of carbonate of lime, often united in a sort of crust. Their formation has been explained by Licopoli. The mother-cell divides simply into four, each of these cells is secretory, their product collects in the intercellular space, and is excreted by the tension of the cells which remain always united on their lower surface. The author states that the inflorescence of all the Plumbagineæ is constructed on the same plan. It is a mixed inflorescence formed of dichotomous cymes, developed singly by abortion, and grouped in a paniculate or capitulate manner.

M. Maury admits the axile nature of the ovule of Plumbagineæ. With regard to the affinities of this natural order, its nearest relationships are with Primulaceæ and Polygonaceæ.

The remaining portion of the memoir is devoted to the geographical relations. Of the 267 species of Plumbagineæ, 52 are European, 123 Asiatic, 39 African, 11 American, and 2 Oceanic; the remaining 40 are common to two or more continents.

* Blottière, R., 'Étude anatomique de la famille des Menispermées,' 71 pp. and 2 pls., Paris, 1886.

† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 284–92 (1 pl.).

‡ Ann. Sci. Nat. (Bot.), iv. (1886) pp. 1–134 (6 pls.).

(5) Structure of Organs.

Origin of the lateral roots in Leguminosæ and Cucurbitaceæ.*—MM. P. van Tieghem and H. Douliot dissent from the statement of Janczewski, that the secondary roots of Leguminosæ and Cucurbitaceæ are formed in a different way from those of other orders of Dicotyledons. They repeat their previous assertion that the young secondary root derives its nutriment from the cells of the mother-root with which it comes into contact. This may take place in three different ways:—(1) The young lateral root is naked, and its digestion is then direct and complete, as in Ferns, Cycadeæ, Conifers, Cruciferæ, Caryophyllaceæ, various Monocotyledones, &c. (2) The young lateral root pushes before it a more or less thick layer of protoplasmic tissue, which continues in a state of activity, and which digests the tissues with which it comes into contact; this layer of tissue they propose to call the *digestive pouch* (*poche*). The digestion is here indirect and partial. (3) This pouch soon disappears from the sides of the lateral root, remaining intact only at its apex; this case is intermediate between the other two. This digestive pouch has been described by previous writers as a false root-cap. The layer of tissue which envelopes and protects the apex of a lateral root is called by the author the cap (*coiffe*) independently of its origin; the portion which belongs to the surrounding tissue they now propose to call the pouch, that which belongs to the lateral root itself the *calyptra*. The lateral roots of Leguminosæ and Cucurbitaceæ have their origin, equally with those of other Dicotyledones, in the pericycle of the primary root or of the stem; their mode of growth is by means of a strongly developed pouch.

Origin of Lateral Organs.†—Herr G. Karsten supports Sachs's statement that the phenomena of growth in plants may all be referred to a common principle, viz. rectangular segmentation. He finds this to be the origin of the secondary roots in all the plants examined, whether monocotyledonous or dicotyledonous. In opposition to Janczewski, he states that the differentiation of the meristem takes place only at a comparatively late period. In *Lycopodium* and *Selaginella* he finds no apical cell in the young leaf-papillæ. As regards Gymnosperms, he agrees with Strasburger rather than Dingler, finding no apical cell either in the rudiments of the leaves or in the growing-point of the stem. In Angiosperms (*Elodea*, *Hippuris*, *Utricularia*) the leaves have the same origin from the growing-point, brought about in all cases by rectangular segmentation of a group of cells, and not by segmentation of a single apical cell, as in mosses and ferns.

Tubers on the Roots of Leguminosæ.‡—Herr F. Benecke confirms the conclusion of Brunchorst,§ that the "bacteroids" found in the tubers on the roots of Leguminosæ are not living bacteria, although endowed with a constant swarming motion, but are ordinary protoplasmic structures of the cells, and the tubers receptacles of food-material. His principal argument in support of this view is that, in *Vicia Faba*, if half of the apex of the root is removed, and the other half gradually developed into a normal root by water-culture, the tubers do not make their appearance until the root has assumed its normal structure, and then in that part which no longer shows any trace of injury.

* Bull. Soc. Bot. France, viii. (1886) pp. 494–501. Cf. this Journal, *ante*, p. 262.
† Karsten, G., 'Ueb. d. Anlage seitlicher Organe,' 32 pp., 3 pls., and 78 figs., Leipzig, 1886.
‡ Bot. Centralbl., xxix. (1887) pp. 53–4. § See this Journal, 1886, p. 271.

Leafy branches of Cupressineæ.*—According to Herr P. Klemm, the principal differences in the anatomical structure of the branches of Cupressineæ depend upon whether they are radiar, bilateral, or dorsiventral, a point which is apparently dependent largely on the illumination. The epidermal cells have a row of pores on their side-walls, the pores of adjacent cells usually corresponding. The cuticle is often covered with a coating of wax, and has usually crystals of calcium oxalate imbedded in it. Besides the central and peripheral stereome, there are also often stereids in the parenchyma, which are generally idioblasts. The palisade-parenchyma is on the morphologically under side of the leaf; the cells of the abducting tissue are elongated in the longitudinal direction, those of the conducting and assimilating tissues in the transverse direction. The conducting system presents no special peculiarities. The stomata are usually on the non-illuminated side, where there is no palisade-parenchyma; their structure is quite of the ordinary kind. The resin-receptacles are either entirely imbedded in the parenchyma, or they are adjacent to the epidermis, causing the formation of channels or pits.

Transparent Dots in Leaves, especially of Connaraceæ.†—Dr. L. Radlkofer describes the various points of structure which give rise to the appearance of more or less transparent dots in species belonging to a large number of different natural orders. Those belonging to the Connaraceæ, especially the genera *Connarus* and *Rourea*, are described in detail, and the value of the character for taxonomic purposes is discussed. A new genus *Pseudoconnarus* is proposed, formed out of *Connarus fecundus*, and distinguished from the typical genus by the absence of dots on the leaves.

Foliar Lenticels.‡—In investigating the large lenticels on the leaves of *Camellia japonica*, Prof. A. Borzì finds that they are essentially connected with the stomata, which are of two kinds. At the time when the young leaves first emerge from the bud, there is no visible trace of lenticels. There are two different sets of stomata, formed at different periods, the first set controlling the respiration during the earlier, the second set during the mature period of the leaf. The epidermal cells from which the second set is formed show scarcely a trace of segmentation at the time when the first set are mature. As soon as the first set become useless by the formation of the second set, their guard-cells are transformed into a corky cushion; and at the same time the subjacent cells of the mesophyll divide by tangential septa, and their walls become suberized. In this way is formed a true lenticel.

The lenticels on the petioles of *Aralia papyrifera* and *Sieboldii* have the form of corky emergences, but present no special points in their structure or mode of origin.

Ochrea of Polygonaceæ.§—According to M. Colomb the ochrea of the Polygonaceæ is a compound structure, composed of two portions, one opposed to the leaf, which is its sheath, the other situated in its axil, and detached from the petiole, which is a ligule. A similar structure occurs in the stipules of *Ficus* and *Magnolia*.

Epidermal Glands containing an Ethereal Oil.‖—Herr J. Behrens describes the well-known multicellular glandular hairs of *Pelargonium*

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 499–541 (4 pls.).
† SB. K. Bayer. Akad. Wiss., xvi. (1886) pp. 299–378.
‡ Malpighia, i. (1886) pp. 219–27 (1 pl.).
§ Bull. Soc. Bot. France, viii. (1886) pp. 506–7.
‖ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 400–4.

zonale, and states that the usual description is inaccurate which places the seat of the formation of the oil between the cuticle and the inner layer of the epidermis. It is first formed in the protoplasm itself, though at a later stage a membrane makes its appearance between the oil-drop and the protoplasm. The oil-glands on the margins of the stipules of *Erodium cicutarium* retain permanently the earlier structure of those of *Pelargonium*, and the same is the case also with those on the sporangia of *Pteris serrulata*. In *Ononis spinosa* the very thin oil found in the protoplasm passes entirely through the outer wall of the gland. The transverse walls of the pedicel-cells of the gland are perforated by a large number of minute pores, through which threads of protoplasm pass from one cell to another. A similar passage of oil through the outer membrane takes place in the glands of *Senecio viscosus*.

Structure of Flowers of Cleome.*—By observations on two species of *Cleome* (*C. spinosa* and *gigantea*) Herr F. Hildebrand confirms the statement of Vöchting † with regard to the movements of the floral organs resulting from gravitation. He finds that, as the position of the flower in this respect is altered, the stigmas and anthers always place themselves in such positions that they are not in contact with one another; the object being apparently to promote cross-fertilization.

Cleistogamous Flowers of Orobanchaceæ. ‡—M. L. Trabut describes a peculiar kind of cleistogamous flower which he has detected in *Phelippæa lutea*, an Orobanchaceous plant from the province of Oran. They are situated below the ordinary flowers, buried in large scales, and produced beneath the surface of the soil. They appear later than the ordinary flowers, and produce smaller capsules, containing seeds in no way differing from the ordinary ones.

Doubling of Flowers.§—Herr F. Hildebrand points out that the doubling of flowers is always a morbid phenomenon, and of no use in nature; the marking of the petals which assists insect-visitors in finding the way to the nectary is usually lost. The tendency to an abnormal development of the corolla (or calyx) varies greatly in different families; in many cases it is so feeble that it is exceedingly difficult in them to obtain double blossoms. External influences can only act on this predisposition in the species to a doubling of the floral organs.

Mimetic Pollen-grains.‖—Herr J. M. Janse records a remarkable instance of mimetism in the flowers of *Maxillaria Lehmanni*, from Central America. On the central region of the labellum is a callosity which is covered by a fine yellow powder which bears an almost exact resemblance to a layer of detached pollen-grains. The author suggests that they are taken for pollen-grains by bees, which devour them eagerly for the large quantity of starch which they contain. In moving about the labellum to feed on this substance, the insect would necessarily strike against the anther, and remove the pollinia with their viscid discs. The substance in question appears to be an epidermal structure, consisting of the detached nearly spheroidal constituent cells of moniliform hairs. Herr Janse believes that this is the first instance recorded of the occurrence of starch in hairs.

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 329–37.
† See this Journal, *ante*, p. 266.
‡ Bull. Soc. Bot. France, viii. (1886) pp. 536–8.
§ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 622–41. Cf. this Journal, *ante*, p. 266.
‖ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 277–83 (1 pl.).

Mechanism of Fruits for the Purpose of Dispersion.*—Herr G. Eichholz describes the arrangement in a number of fruits by means of which the bursting or twisting is brought about which promotes the dispersion of the seeds. This is generally effected by the adaptation of certain cells, either from their first formation or shortly before they become ripe. These special cells may be arranged in two groups, according as they contract most strongly, on desiccation, in the longitudinal or in the transverse direction. The curve in the tissue resulting from unequal contraction of these elements may be either double or single; and in the latter case may result from contraction of the concave or from elongation of the convex side.

As regards the details of the structure in special cases:—In *Impatiens* the layer of pericarp which swells is a mechanism resembling a bladder which is drawn out by hydrostatic pressure. The change of form of the cells determines the direction, the great extensibility of the membranes the extent of the expansion. The fibrous or resisting layer has very little flexibility, but great traction. In Rutaceæ the endocarp has a hinge-structure. In *Dictamnus*, but not in *Ruta*, the endocarp is thrown out together with the seeds. In the Rutaceæ, Liliaceæ, and Rhodoreæ the curvature is brought about by the dynamo-static elements being placed transversely on the concave, vertically on the convex side. In *Fagus*, *Epilobium*, and *Datura*, the thin-walled parenchyma is the contracting tissue. In *Epilobium* the median vascular bundle takes no part in the contraction. In *Pinus*, *Eschscholtzia*, *Acacia*, *Acanthus*, and *Scandix*, the curvature is the result of a constant difference in the direction of the pores in the fibrous elements. The isodiametrical thick-walled cells of *Weigela*, *Azalea*, and *Rhododendron* have two functions; they contribute to the curvature in a vertical plane; and they cause also the curvature in a horizontal plane, which is essential for the perfect release of the seeds. The isodiametrical cells of *Primula* exercise a traction in the vertical direction only.

β. Physiology.†

(1) Reproduction and Germination.

Fertilization of Orchideæ.‡—M. L. Guignard confirms the statement of previous observers that the formation of the ovules in Orchideæ is the result of the activity of the pollen-tubes.

In *Vanilla aromatica* the pollen-grains germinate a few hours after being placed on the stigma, which is covered by a gelatinous secretion. The ovary, which, at the period of pollination, is about 4 cm. long, immediately begins to lengthen, until it attains a length of about 20 cm. At the same period the ovules have merely attained the state of small papillæ on the placenta. On the fifth or sixth day after pollination the nucellus is visible at the summit of the papilla, which then begins to curve on the funicle. On the eighth day the inner integument begins to be formed by division of the epidermal cells; the formation of the outer integument follows, and the mother-cell of the embryo-sac increases in size at the summit of the nucellus beneath the epidermis. On the twelfth day the ovule has become anatropous; the internal coat reaches almost to the summit of the nucellus; the outer coat is still very short, but passes the internal coat about the twentieth day. During this time the mother-cell of the embryo-

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 543–90 (4 pls.).

† This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

‡ Ann. Sci. Nat. (Bot.), iv. (1886) pp. 202–40 (2 pls.). Cf. this Journal, 1883, p. 84.

sac has divided into three superposed cells, the two upper of which disappear and the lowermost developes into the embryo-sac; in this the sexual apparatus consists of a large oosphere and two synergidæ with very thin membranes. This apparatus is definitely constituted, in most of the ovules, rather more than a month after pollination; five weeks later impregnation commences, and is completed in about a week.

The pollen-grain has two nuclei, which are always found near the extremity of the pollen-tube; the hinder one, which is the generative nucleus, usually divides into two. The tubes arrive at the base of the cavity of the ovary about twelve or fifteen days after pollination; they do not penetrate into the micropyle of the ovule until after the formation of the sexual apparatus.

In *Vanda tricolor pallens* the interval between pollination and fecundation is about six months; in *Angræcum superbum* about four months; in *Phajus grandifolius* two months; in different species of *Cypripedium* from three to four months; in *Saccolabium giganteum* the ovular papillæ have not even made their appearance one month after pollination. In European orchids the process is more rapid. In *Orchis Morio* there is an interval of fifteen days; in *O. latifolia* three weeks; in *O. Simia* thirteen days; in *O. ustulata* and *pyramidalis* eight to ten days; in *Gymnadenia conopsea* fifteen days; in *Ophrys arachnites* three weeks; in *Limodorum abortivum* twenty-five days.

The pollen-tubes enter the ovary, through the conducting tissue of the gynostemium, in six bundles, which pass down the angle formed by each placenta with the wall of the ovary, while the ovules are still quite rudimentary. Contrary to the statement of Degagny,* he finds that many of the tubes have transverse septa.

M. Guignard confirms the observation of Van Tieghem,† of the production by the passage of the pollen-tube of a kind of ferment, and regards the development of the ovules as a kind of hypertrophy resulting from access of abundance of nutriment. He compares it to the action on vegetable tissues of such parasites as *Synchytrium* and *Plasmodiophora*.

Fertilization of Verbascum.‡—M. P. Maury has closely examined the mode of pollination and impregnation in several species of *Verbascum*, as well as the development of the stamens. The formation of the anther-lobes and of the mother-cells of the pollen-grains occurs at a very early period. Pollination takes place at the moment of the dehiscence of the anther; but, all the species being decidedly proterandrous, the mode of fertilization is indirect or entomophilous. The most remarkable fact connected with impregnation, is that, at the period of pollination, the ovules are still in a rudimentary condition, and altogether unfit for fertilization. The nucellus is entirely occupied by the embryo-sac, in the protoplasmic contents of which there is as yet no differentiation of oosphere, synergidæ, or antipodals. It is only after the pollen-tube reaches the micropylar canal that these begin to be formed. There being no nectary in any species of *Verbascum*, insects appear to be attracted mainly by the coloured hairs attached to the filaments and by the striæ at the base of the corolla.

Fertilization of Greenland Flowers.§—Prof. E. Warming has examined the flora of Greenland between lat. 64° and 69° 15′, especially from the

* See this Journal, 1886, p. 273. † Ibid., *ante*, p. 273.

‡ Bull. Soc. Bot. France, viii. (1886) pp. 529–36.

§ Overs. K. Danske Vidensk. Selsk., 1886, pp. xxv.–xxxiii. (French résumé), and 101–59 (13 figs.).

point of view of the mode of pollination of the flowers. As compared with Arctic Norway, Greenland is very poor in insects, and the flowers display a corresponding increased tendency to autogamy. This is well illustrated in *Menyanthes trifoliata*, which, instead of being heterostylous, as elsewhere, has become completely isostylous. 138 species of anemophilous plants are named, exclusive of the willows. The entomophilous flowers of Greenland all possess nectar; but the number of scented flowers is small. The flowers appear to decrease in size with the increase of latitude; and the brilliancy of colour certainly does not become greater. There are a considerable number of unisexual entomophilous flowers. The author has made no exact observations on the species of insects visiting the flowers.

Pollination of Flowers.*—Dr. J. M'Leod has observed that if pollen-grains are thrown into a weak aqueous solution of sugar, they will, in a few hours, all burst or put out their pollen-tubes; but that if the solution is made more concentrated, the putting out of the pollen-tubes will cease. For each species there is an optimum concentration, and a maximum concentration, beyond which no emission of pollen-tubes takes place. In the case of heterostylous flowers (*Primula elatior*, *Hottonia palustris*), he finds the maximum concentration to be lower for the small than for the large pollen-grains. Dr. M'Leod adds a series of observations on the visits to flowers of night-flying moths, and of the mode of insect-pollination of a number of species from different localities.

Germination of the Cocoa-nut Palm.†—Prof. J. von Sachs describes the development of the seedling cocoa-nut. At the commencement of the germination the young embryo, only a few millimetres in size, is split in two by the growth of the cotyledon, its basal portion, which contains the growing-point of the stem, penetrating into the hard putamen, and putting out the first roots and shoot. At the same time, there is formed at the apical end of the cotyledon a swelling of very loose tissue, the haustorium, which eventually attains the size of a small onion. This organ gradually consumes the whole both of the milk and the endosperm, carrying the nutrient material to the growing seedling, and, at the same time, excreting a ferment. By this time, which occupies about two years in cultivation, but probably a much shorter time in the tropics, four or five leaves have been formed.

(2) Nutrition and Growth.

Absorption of Carbonic Anhydride by Leaves.‡—MM. P. P. Dehérain and L. Maquenne cite determinations which confirm the conclusions already arrived at by them, namely, that the absorption of carbonic anhydride by vegetable tissues is a true phenomenon of solution varying with the temperature, as in all cases of absorption of gas by an inert solvent; consequently, when the leaf respires in an atmosphere kept at constant pressure, this gives rise to a supersaturation comparable with that of a mass of water into which calcium carbonate and hydrochloric acid have been introduced simultaneously. This absorption of carbonic anhydride by leaves is extremely rapid, at any rate when the leaves are in a vacuum, in consequence of the large surface exposed.

Increase in thickness of Palm-stems.§—By examination of the stem of a considerable number of species of palm, the late Prof. A. W. Eichler con-

* Bot. Centralbl., xxix. (1887) pp. 116–21, 150–4, 182–5, 213–6.
† SB. Phys.-Med. Gesell. Würzburg, 1886, pp. 20–3.
‡ Ann. Agronom., xii. (1886) pp. 526–34. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 172. Cf. this Journal, 1885, p. 678.
§ SB. K. Preuss. Akad. Wiss. Berlin, 1886, pp. 501–9 (1 pl.).

firms De Bary's view that the increase in diameter of the internodes of palm-stems is due to the increase in volume of the elements already in existence, rather than to any fresh formation of cambium. Prof. Eichler found this increase to be on the average not less than that of the stems of Dicotyledons and Conifers. The capacity for this increase in size on the part of the elements may be retained for a very long period.

Growth of Pollen-grains.*—By observation of the proportion between the amount of carbon dioxide evolved, and that of oxygen absorbed, M. L. Mangin finds that the growth of pollen-grains is effected in three different ways. In the case of grains containing abundance of starch, such as those of *Betula verrucosa*, *Iris pseudacorus*, *Plantago major*, the hazel, hornbeam, poppy, &c., their germination is independent of the nutritive substratum, they consume their own reserve-material, and the production of carbon dioxide remains constant. In grains containing no starch, such as those of *Agraphis nutans*, *Narcissus pseudo-narcissus*, *Gentiana lutea*, *Digitalis*, *Vinca*, &c., they obtain their food-material from the outside, and then disengage a large amount of carbon dioxide. In some Coniferæ and in *Nymphæa alba*, the reserve of starch in the pollen-grains does not disappear, but fresh supplies are formed in the cavity of the pollen-grain and in the pollen-tube, which are used up by the latter in its developement. M. Mangin's observations were made on pollen-grains made to germinate artificially in a nutritive medium, such as glycerin or a solution of sugar.

Ripening of Seeds.†—M. A. Muntz states that unripe rye-grain contains a notable proportion of synanthrose, a sugar analogous to cane-sugar, and only found up to the present time in the roots or tubercles of certain Compositæ. The proportion in the dry grain varied between 45 per cent. and 6·85 per cent. Young colza seed contains cane-sugar and a reducing sugar having the rotatory power of invert-sugar; at maturity cane-sugar alone remains. By determining from time to time the sugar, starch, oil, and nitrogenous matter in a constant number of colza seeds, the author finds that the glucose diminishes gradually and disappears, the cane-sugar increases, the starch, always present in small quantity, gradually diminishes, the nitrogenous and oily matters constantly increase. It therefore appears that the seed itself does not contain the carbohydrates which undergo transformation into oil; but that sugar and starch constantly flow there, and disappear after a short sojourn, thus probably furnishing the material out of which the oil of the seed is elaborated.

(3) Movement.

Ascent of Sap.‡—According to Prof. S. Schwendener, the most recent investigations of the movements of water in plants tend more and more to show the insufficiency of the imbibition theory, and to lead to the conclusion that the seat of these currents is mainly the cavities of the tracheïds and vessels rather than their walls. A fresh series of experiments and observations undertaken by him confirm these results. During the summer months the stems of most lofty trees contain no unbroken columns of water. The suction from the leaves and the root-pressure are not by themselves adequate to account for the rise of the sap; other factors must be sought for; these are not yet fully known; but among the more

* Bull. Soc. Bot. France, viii. (1886) pp. 512–7. Cf. this Journal, *ante*, p. 269.

† Ann. Agronom., xii. (1886) pp. 399–400. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 173.

‡ SB. K. Preuss. Akad. Wiss. Berlin, 1886, pp. 561–602 (3 figs.). Cf. this Journal, 1886, p. 1016.

important of them must be osmose and the filtration necessarily connected with it.

Prof. Schwendener specifies those natural orders in which there are no other mechanical elements than more or less thick-walled libriform cells with bordered pits; those which possess, in addition to these stereids, libriform cells with a few unbordered pits; those which have a homogeneous libriform or stereome with a few unbordered pits; and finally, those in which the different genera differ from one another on these points.

Periodicity in the Phenomena of Bleeding.*—Herr C. Kraus has detected a daily periodicity in the chemical nature of the sap exuded from cut stems (turnip, maize, sunflower, hop), indicating corresponding variations in the root-pressure. The most common sequence exhibited was:—slightly alkaline in the morning, strongly acid in midday, and nearly neutral in the evening. Before the close of the "bleeding" the sap ceased to exhibit any acid reaction throughout the day.

Absorption of Water by Terrestrial Organs.†—Herr L. Kny gives more in detail the experiments according to which *Dipsacus laciniatus* and *Fullonum*, alone among the plants examined, possess the power of absorbing water in the form of drops through their leaves, the latter species having it to the greater degree. Even here, however, the amount absorbed from the trough formed by the connate bases of the opposite leaves is very small compared to that supplied through the root. No very striking difference was found in the anatomical structure of the tissue of which this trough is composed, as compared with that of other parts of the plant. The author does not consider that the glandular hairs observed by Prof. F. Darwin on this part of the leaf take any part in the absorption of the water.

Structure and Coiling of Tendrils. ‡—M. Leclerc du Sablon has investigated the anatomical causes of the coiling of tendrils in the Cucurbitaceæ, Passifloraceæ, Smilaceæ, and Ampelideæ, and in other genera in which they occur. He finds a constant relation between the sensitiveness of any region of the tendril and its anatomical structure. The sensitiveness of a surface is proportionate to the number of thin-walled fibres or of very elongated cells in its vicinity. Their anatomical structure is, however, only one factor in bringing about the coiling of tendrils; their form, flexibility, and movements being other factors. The author does not consider the unequal growth of the two sides of the tendril as an adequate explanation of the cause of its movements. The helicoid contraction of the free part of a fixed tendril he regards as quite independent of the extension of the coiling round a support; it should rather be compared to the spontaneous coiling of a tendril which has not reached any support.

Theory of Twining.—Herr H. Ambronn replies § to the criticisms of Wortmann ‖ on his own and Schwendener's theories on the causes of the twining of climbing stems. He charges Wortmann with confusing the elementary ideas of dextrodromal and sinistrodromal torsions, and especially contests his aphorism that "the movement of coiling is identical with circumnutation."

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 319–22.

† Ibid., Gen.-Versamml., pp. xxxvi.–lxxiv. Cf. this Journal, *ante*, p. 119.

‡ Bull. Soc. Bot. France, viii. (1886) pp. 480–3, and Ann. Sci. Nat. (Bot.), v. (1887) pp. 5–50 (3 pls.).

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 369–75.

‖ See this Journal, *ante*, p. 118.

To this Herr J. Wortmann replies * maintaining the correctness of his previous statements and theories; and the controversy is again taken up by Ambronn.†

(4) Chemical Changes (including Respiration and Fermentation).

Respiration and Growth.‡—Herr W. Palladin gives the result of a number of experiments on a variety of plants, from which he draws the following general conclusions:—The changes in the process of respiration under the influence of growth have a qualitative, but no quantitative character. The proportion $\frac{CO_2}{O_2}$ is less than unity during the respiration of growing organs. The result of respiration in growing organs appears to be the storing up of substances, such as organic acids, which produce turgidity in the cells. Growth ceases in an atmosphere devoid of oxygen in consequence of the cessation of the formation of these substances.

Intramolecular Respiration of Plants.§—In pursuance of previous investigations on this subject, Herr N. W. Diakonow formulates his general conclusions as follows:—That no separation of carbon dioxide, and hence no life, can exist without the access of free oxygen or the action of a nutrient material capable of undergoing fermentation; and that the processes of respiration and fermentation are mutually exclusive of one another.

Alcoholic Fermentation of Dextrin and Starch.‖—MM. U. Gayon and E. Dubourg state that they have met with a species of *Mucor* which has the power of converting dextrin and starch into sugar, and then fermenting the sugar; but, like *M. circinelloides*, it has not the power of inverting cane-sugar, and transforming it into alcohol. Other non-inversive ferments, on the other hand, have not the power of fermenting dextrin and starch. In beer-wort or solutions of glucose, this mucor developes rapidly in large spherical ferment-cellules. In dextrin or starch it at first forms mycelial tubes, which soon swell up, divide, and form themselves into globular masses. In yeast-water containing sugar, the mucor forms only a bulky unicellular mycelium. The fermentation of dextrin takes place somewhat slowly, and that of starch requires still more time. The dextrin existing in beer is readily saccharified by this mucor and converted into alcohol, if the alcohol already in the beer is expelled before adding the ferment.

Eurotium Oryzæ, used in the manufacture of "koji," secretes a diastase which converts rice into a true malt, and this fungus also inverts cane-sugar, but it cannot carry fermentation any further.

γ. General.

Chlorosis in Plants.¶—Prof. J. v. Sachs states, that, when attacked by this disease, the leaves pale and turn perfectly white; weak plants succumbing quickly. Stronger ones are attacked year after year until their reserve-material is exhausted, when they die. The touching of a diseased leaf with a dilute solution of an iron salt often causes the production of chlorophyll and cures the disease. However, from extended observations, the author

* Op. cit., pp. 414–21. † Op. cit., v. (1887) pp. 103–8.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 322–8.

§ Ibid., pp. 411–3. See this Journal, 1886, p. 835.

‖ Comptes Rendus, ciii. (1886) pp. 885–7.

¶ Bied. Centralbl., 1886, pp. 602–4. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 76.

does not think that it is altogether the absence of iron that causes the disease, as plants growing on the same soil are attacked irregularly, some escaping altogether. His experience leads him to think that the roots or conducting vessels suffer some alteration which prevents the minute quantities of iron contained in the sap from reaching the leaves. A too rapid and luxuriant growth favours the disease. The following experiment has, he considers, an important bearing on vegetable physiology. Certain acacia trees showed symptoms of chlorosis, in particular the thick branches of a twenty-year old tree. The author caused holes to be bored in the main stem, just beneath the bifurcation of the branch with the core of the tree. In these holes he placed corks fitted with funnels, charged afterwards with ferrous sulphate or ferric chloride in solution. In dry weather the tree absorbed the solutions readily, the leaves in the line of each funnel becoming quite green in 10 to 14 days, while those not in the line remained white. This the author thinks a proof that each branch and twig has its own sap-ducts.

Freezing of Tissues.*—Herr H. Müller-Thurgau gives the details of a large number of experiments connected with the freezing of tissues, especially on potatoes and on leaves. He regards the cause of the death of the protoplasm to be not so much the low temperature or the desiccation, or the processes connected with thawing, as the actual freezing itself.

Plants poisonous to Fish.†—Dr. L. Radlkofer gives a list of upwards of 150 species of flowering plants which are more or less poisonous to fish, many of which are used for purposes of fishing.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Gemmiparous roots of Anisogonium.‡—M. P. Lachmann observed in *Anisogonium* [section of *Asplenium*] certain roots, the radicular nature of which was fully determined, and which gave rise to a bud at their apices. On the exterior the passage of the root to the bud is marked by a very apparent swelling; on the interior a transition of radicular to cauline structure is noticed. These buds develop and give rise to stems with ordinary fronds.

Muscineæ.

Anatomy and Physiology of Mosses.§—Dr. G. Haberlandt enters, in great detail, into the structure of the vegetative organs of Mosses. The following is a summary of the more important conclusions arrived at, the author regarding the histological differentiation of Musci as much more advanced than is generally assumed.

(1) The epidermal system is represented by an epidermis which is usually typically developed on the sporogonium, and is sometimes covered by a coating of wax. On it are sometimes developed trichomic structures, as on the calyptra of *Polytrichum.* The tuberous stem of *Buxbaumia aphylla* has a suberous epidermis.

(2) The mechanical system consists of stereids, characterized not only

* Landwirths. Jahrb., xv. (1886) pp. 453–609 (4 pls.). See Bot. Centralbl., xxix. (1887) p. 76.

† SB. K. B. Akad. Wiss. München, xvi. (1886) pp. 379–416.

‡ Bull. Soc. Bot. Lyon, May 25, 1886. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 227.

§ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 359–498 (7 pls.).

by their elongated parenchymatous form and thickened walls, but by dots resembling longitudinal or oblique fissures. They are thus adapted for special mechanical purposes, either to resist flexion and traction, as in the rhizomes of *Polytrichum*, or for local strengthening.

(3) The absorbing system is especially represented by the rhizoids, which display no less adaptation for this purpose than root-hairs. In the saprophytic mosses this adaptation is particularly strongly displayed in haustorium-like structures (*Eurhynchium prælongum*), perforating appendages (*Webera nutans*), or a structure resembling the hyphæ of fungi (*Buxbaumia*). The foot of the sporogonium is usually provided with a papillose absorbing tissue.

(4) The assimilating system, frequently imperfectly developed in the leaves, is sometimes developed in its most perfect form in the capsule as a palisade-tissue (*Funaria hygrometrica*, *Bryum argenteum*, &c.); sometimes also as a spongy parenchyma rich in chlorophyll (*Physcomitrium pyriforme*, *Zygodon Forsteri*); or there are intermediate forms, as in *Webera elongata* and *Meesia longiseta*.

(5) The conducting system consists of simple or compound cauline bundles, and of foliar bundles with or without leaf-traces. The latter have blind endings in the cortex of the stem (*Mnium*), or unite with the cauline bundle (*Splachnum*, Polytrichaceæ). The seta almost always possesses a conducting bundle. The simple central bundle consists entirely of aquiferous cells which may be regarded as tracheïds of the simplest kind. Their walls are usually thin and smooth, but there are sometimes delicate reticulate sculpturings in the ends of the bundles (*Mnium punctatum*, *Bryum leucotrix*). The compound bundles of the Polytrichaceæ belong to the concentric type. The central hadrome bundle either consists entirely of aquiferous cells (*Pogonatum*, *Polytrichum*), or also of an intercalary conducting parenchyma (*Atrichum undulatum*). In *Dawsonia superba* and the rhizome of *Polytrichum*, the central cylinder is composed of aquiferous cells and a mechanical tissue. The leptome-sheath is chiefly employed in the conduction of albuminoids, and consists, when most completely differentiated, of sieve-tube-like rows of cells, between which are cells resembling cambiform (*Polytrichum juniperinum*). In the seta the central bundle is sometimes surrounded by a well-developed protecting sheath (*Funaria hygrometrica*, *Meesia longiseta*).

(6) The reserve-system is represented by the aquiferous tissue usually present in the capsule, and by small tuberous reservoirs of reserve-material, which occur in some species as shortly stalked appendages to the rhizome or protonema, as also in the parenchyma of the stem of *Buxbaumia*.

(7) The aerating system is typically developed in the sporogonium. The stomata often entirely resemble those of flowering plants in their structure and mechanism.

(8) No secreting or excreting organs have as yet been discovered in Mosses.

The author gives a special description of several saprophytic mosses. *Buxbaumia* he describes as entirely destitute of assimilating leaves. Finally he discusses the phylogenetic relationship of the various forms of Musci.

Homologies of Mosses.*—M. P. Vuillemin objects to the term alternation of generations as applied to mosses; he regards their stages of development rather as a kind of metamorphosis. In the evolution of a moss there are three phases :—(1) The thallophytic phase, reduced to what

* Vuillemin, P., 'Sur les homologies des Mousses,' 59 pp., Nancy, 1886.

is ordinarily called the protonema; (2) the bryophytic phase, the equivalent of which is peculiar to this group; (3) the phanerogamic phase, commonly called the asexual generation. The fertilized oosphere of mosses, like that of Phanerogams, gives birth directly to an embryo destined to produce definite organs. This is not the case with Vascular Cryptogams, and the Muscineæ are hence less differentiated from Phanerogams than are Vascular Cryptogams, in which the stem, root, and leaf are developed directly at the expense of the oosphere. The sporogonium of mosses is a derivative of the tigellum, in the same sense as the stem of higher plants; in the foot and the sporogonium are found all the anatomical regions of the stem, cortex, epidermis, endoderm, pericycle, and medulla. The spores originate from the pericycle.

Heterosporous Muscineæ.*—In addition to the examples already given, Herr C. Warnstoff records the occurrence of microspores in *Sphagnum cuspidatum* and *cymbifolium*. He believes them to be not accidental structures, but to be homologous to the microspores of the heterosporous vascular cryptogams, probably producing on germination a male prothallium.

Herr Warnstoff has also detected two kinds of spore in some Hepaticæ, especially in *Blyttia Lyellii*. The long cylindrical capsules, which split into four lobes, contain both large roundish-tetrahedral and small spherical spores, the former having a diameter of from 0·021 to 0·025 μ, the latter from 0·012 to 0·016 μ. Though the germination of the spores has here also not been actually observed, he believes that the macrospores produce female, the microspores male individuals.

Distribution of Mosses.†—M. R. Hult describes in detail the moss-flora of Finnish Lapland, amounting to 285 species, including 54 Hepaticæ and 15 Sphagnaceæ. He discusses the causes which are most efficacious in promoting the distribution of mosses, and gives reasons for doubting the prevalent theory that it is mainly due to the spores being carried great distances by the wind.

Algæ.

Gelatinous Sheath of Algæ.‡—Herr G. Klebs has examined critically the structure and origin of the gelatinous sheath which invests the filaments of many algæ, and also some Flagellata.

In the Zygnemaceæ this sheath is composed of a substance entirely independent of the cell-walls. It consists of two portions:—a homogeneous substance which is but slightly refringent, and which is indifferent to the action of staining reagents, and a portion which absorbs pigments (methyl-blue, methyl-green, vesuvin, &c.) with avidity, and which is composed of minute rods at right angles to the cell-wall. Under the action of Prussian blue it swells, becomes irregular, and finally disorganized. These reactions are exhibited only by the sheath of the living plant. Its substance does not comport in its reactions with the ordinary mucilage of vegetable cells; it is not dissolved by alkalies; treated with hot water or with chloriodide of zinc it loses its power of absorbing pigments. The author maintains that the substance of the sheath is derived directly from the cytoplasm of the cells through the cell-wall. It is always quite distinct from the cell-

* Verhandl. Bot. Ver. Prov. Brandenburg, 1886, pp. 181–2. See Bot. Centralbl., xxix. (1887) p. 198. Cf. this Journal, 1886, p. 830.

† Acta Soc. pro Fauna et Flora Fennica, iii. (1886). See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 193.

‡ Unters. Bot. Inst. Tübingen, ii. (1886) pp. 333–418 (2 pls.).

wall, and must be formed by apposition and not by intussusception. This was shown by the mode of deposition in the sheath of particles of salts of iron and lead when the alga was grown in dilute solutions of these salts. The passage of its substance through the cell-wall can be proved in a similar way.

The structure and origin of the gelatinous sheath in the Desmidieæ is essentially the same as in the Zygnemaceæ; this is also the case with *Chætophora* and *Sphærozyga*.

In *Chroococcus helveticus* the gelatinous sheath is homogeneous and capable of swelling, in *Glœocystis ampla* it is composed of two successive layers. The stalk of some diatoms (e. g. *Gomphonema*) is composed of a gelatinous substance the density of which increases towards the outside; it swells but slightly, but is intensely coloured by anilin pigments. It is entirely independent of the cell-wall.

Among the Volvocineæ the gelatinous sheath of *Glœomonas ovalis* swells greatly, that of *Pandorina* less, that of *Gonium* and *Eudorina* least of all. The rod-structure is distinct in *Pandorina* and *Gonium*, less so in *Eudorina*, while the sheath of *Glœomonas* is apparently homogeneous. In *Volvox* the separate individuals of a colony have no distinct sheath of their own, but lie immersed in a common gelatinous mass which fills the interior of the sphere. This gelatin is traversed by delicate strands of a denser and more resisting material. Towards the periphery may be detected a membrane of polygonal outline derived from the original walls of the separate cells.

A gelatinous sheath can be detected in nearly all the Flagellata by the use of sufficiently dilute staining materials; and this sheath is evidently due directly to the activity of the protoplasm. In *Euglena sanguinea* it is secreted in the form of straight or more or less curved filamentous bodies. In the social forms the gelatin consists of a fundamental substance, immersed in which are denser granular corpuscles. Both substances are coloured by anilin-pigments. The brown or black colour of the sheath of these colonies is due to the deposition of oxide of iron.

Anatomy and Development of Agarum Turneri.*—Mr. J. E. Humphrey states that the anatomy of the Laminariaceæ shows great uniformity; taking place, in this as in other species, by intercalary growth at the junction of stipe and lamina. A pith, an internal cortex, an external cortex, and an epidermis containing the coloured pigment, are here to be distinguished. In young specimens the pith is not differentiated, the differentiation only taking place slowly. M. Reinke has described a zone of growth as existing in the Laminariaceæ; this zone is present in *Agarum*, but is accompanied by a second sub-epidermal cambium. As for the perforations, the author shows how they are produced; the blade is covered with hollow conical papillæ, the tissue diminishes at the apex of the cones, then bursts, and the opening enlarges as the frond grows.

Marine Vaucherias.†—Prof. O. Nordstedt described the marine species of *Vaucheria* of the English and Scotch coasts, the thickness of the filaments, and length of the oogonia and antheridia, being accurately given. *V. sphærospora* he describes as both monœcious and diœcious, and unites with it *V. subsimplex*.

Binuclearia, a new genus of Confervaceæ.‡—Prof. V. B. Wittrock describes under this name a fresh-water alga found at high altitudes in

* Proc. Amer. Acad. Arts and Sci., 1886, p. 195 (2 pls.).
† Scottish Naturalist, 1886, 4 pp. and 1 pl.
‡ Bot. Sällsk. Stockholm, Feb. 17, 1886. See Bot. Centralbl., xxix. (1887) pp. 60 and 89 (2 figs.).

Hungary and Norway. The genus is characterized by each cell of the cylindrical unbranched filaments containing two nuclei of unequal size; the dissepiments of the cells are also of unequal thickness. There is in each cell one parietal chlorophore. Multiplication takes place by bipartition of intercalary cells, no zoospores having at present been detected. Each vegetative cell appears to consist of two parts, one older with a larger nucleus and a thicker dissepiment, the other younger with a smaller nucleus and a thinner dissepiment. In one stage resting-cells appear to be formed in the same way as in some other Confervoideæ.

Layer of Earth composed of Algæ.*—Prof. V. B. Wittrock finds near Stockholm a layer of soil 0·2–0·6 metres in thickness, at a little depth below the surface, composed chiefly of filaments of *Vaucheria*, with which some diatoms and remains of flowering plants were intermixed. The species could not be determined.

Intermediate Bands and Septa of Diatoms.†—By the term "intermediate bands" (Zwischenbänder) Herr O. Müller designates certain bands which are found in many diatoms between the valves and the girdle-bands, formed after the development of the young valve, but before the appearance of the young girdle-band. They must be regarded, like these structures, as independent members of the cell-wall. There may be one only or several of these bands in each half of the cell; in the latter case the number in the two halves is often unequal. The space inclosed by the valves and the intermediate bands is often divided by septa, which is never the case with the space inclosed by the girdle-bands. The intermediate bands are either continuous annular portions of the membrane, like the girdle-bands, or are open bands. *Grammatophora maxima* is described as affording a typical example of a species with a single intermediate band; in *Tabellaria* each half-cell has several; and in *Odontidium hyemale* at least two; while the genus *Rhizosolenia* furnishes species with a large number of open bands which are not septated.

Movement of Diatoms.‡—In the valves of certain diatoms, Dr. O. E. Imhof describes pores through which the protoplasm is protruded in fine processes. The forms investigated were a large *Surirella* species and a *Campylodiscus* found in the alpine lakes of the upper Engadine. When the sides of the *Surirella* were disposed at right angles to the glass a row of very minute elliptical apertures could be detected along the edge of the empty valves. The protrusion of protoplasm was also observed. The four sides exhibit a large number of fine conical canals, occurring in a definite relation to the familiar markings. These canals open on the edge of the sides as noted above. Along the edge there runs a shallow gutter. Through each tubule a fine process of protoplasm is protruded, and all are connected by the strand lying along the gutter. Some permanent preparations were made. The structure of *Campylodiscus* is essentially the same. Fuller details are promised.

Diatoms of the 'Challenger' Expedition.§—The Report on the Diatomaceæ of the 'Challenger' Expedition, by Count F. Castracane, commences with a succinct but admirable account of the general structure and biology of the group. The phenomena of conjugation and of the formation

* Bot. Sällsk. Stockholm, April 27, 1886. See Bot. Centralbl., xxix. (1887) p. 222.
† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 306–16 (1 pl.).
‡ Biol. Centralbl., vi. (1887) pp. 719–20.
§ Report of the Voyage of H.M.S. 'Challenger.' Botany, vol. ii., 178 pp. and 30 pls., 4to, London, 1886.

of auxospores he looks on as only occasional modes of reproduction, and not as typical of the whole group.

With regard to the geographical distribution of diatoms, the author regards it as certain that several distinct floras exist; although it may be premature to determine finally the question of distribution according to the genera and species that inhabit different areas. The question of the dependence of life at great depths in the ocean on the penetration of sunlight is then discussed, as well as the formation of banks and deposits of diatoms.

The bulk of the volume is occupied with descriptions of the species collected, the immense majority being either new species or new varieties; each description is accompanied by a plate. The following are new genera:—

Cyclophora (Pseudoraphidieæ). Frustula tabulata, rectangula, in fascias conjuncta, rarius soluta; isthmo gelineo alterne concatenata; a fronte linearia vel parum inflata; valvis inæqualibus, quarum una loculo centrali instructa.

Dactyliosolen (Cryptoraphidieæ). Distinguished from *Rhizosolenia* by the occurrence in the course of the filaments of hyaline belts. Forma cylindrica; frustulum compositum ex pluribus annulis cellulatis; cellulis linearibus oblongis.

Corethron (Cryptoraphidieæ). Frustula cylindrica libera (?); valvis convexis, setarum radiantium corona cinctis.

Willemoesia (Cryptoraphidieæ). No diagnosis given.

Ethmodiscus (Cryptoraphidieæ). Frustula solitaria, discoidalia; valvis tenuissime et inconspicue striolatis; forma plus minus convexa, quandoque diversimode denticulata, zona connectiva punctulata.

Reproduction in a Fossil Diatom.*—Count F. Castracane describes the appearance presented by a fossil diatom from Monte Gibbio, which he identifies with *Coscinodiscus radiolatus*, consisting of the impressions of a great number of closely packed round bodies on the edge of the valve. These he believes to be impressions of embryonal forms still remaining within the mother-cell at the time of its death, exhibiting therefore a similar mode of reproduction to that which he had already observed in the case of *Podosphænia*.†

Fossil Diatoms from Umbria.‡—Count F. Castracane describes a calcareous deposit from Spoleto in Umbria, extremely rich in diatoms, especially in species of *Epithemia* and *Cyclotèlla*, of great size and beauty.

Lichens.

Synthesis of Lichens. §—M. G. Bonnier has succeeded in obtaining by artificial culture, in an atmosphere which has been completely sterilized, by the process of synthesis, several species of corticolous lichens, viz. *Parmelia Acetabulum* and *Physcia parietina* and *stellaris*, as well as *Lecanora sophodes* and *ferruginea* among saxicolous species. The constituent alga was a *Protococcus* or *Pleurococcus*. Two sets of experiments were made:—in the one set one of these algæ, in the other set the gonidia of a lichen, were sown in closed and sterilized cells in conjunction with the hyphæ of a fungus. In the latter case no development took place; in the former case a true lichen-thallus was obtained under the same conditions. Experiments

* Atti Accad. Pont. Nuovi Lincei, xxxviii. (1886) 6 pp. and 1 fig.
† See this Journal, 1885, p. 1041.
‡ Atti Accad. Pont. Nuovi Lincei, xxxviii. (1886) 7 pp.
§ Comptes Rendus, ciii. (1886) pp. 942–4, and Bull. Soc. Bot. France, viii. (1886) pp. 546–8.

by Pasteur's method, at high elevations in the Alps and Pyrenees, were still more successful, fructifications being in some instances developed on the lichen-thallus thus obtained by synthesis of an alga and a fungus.

Schwendener's Lichen-theory.*—M. C. Flagey gives a *résumé* of the literature for and against this theory; he sums up strongly against it, and in favour of Minx and Müller's hypothesis of microgonidia. Lichens he regards as autonomous and perfectly distinct organisms, allied with Algæ through *Collema*, and with the ascosporous Fungi through the Verrucarieæ, but always distinguishable from them by the chlorophyll contained in their hyphæ. Lichenin he considers to be an amylaceous substance peculiar to lichens, replacing the fungin of true fungi. M. Flagey lays stress on the unsatisfactory nature of the synthetical experiments of Bornet, Stahl, and others, inasmuch as they reconstructed lichens out of fungal hyphæ and the gonidia of lichens, rather than out of what they state to be their constituent elements, fungi and true algæ.

Hymenolichenes.†—M. O. J. Richard combats the view of Johow ‡ with regard to the compound nature of the genera *Cora* and *Dichonema*. He believes his statements to have been founded on imperfect observation of sterile specimens only, and confirms that of Nylander of the occurrence of apothecia on the thallus of *Cora*.

Fungi.

Formation and Liberation of Zoospores in Saprolegnieæ.§ — Dr. M. M. Hartog comes to the conclusion that the clear bands of the first stage of the zoosporange are neither cell-plates nor nuclear plates, but thinner parts of the protoplasm due to the aggregation of the greater part around distinct centres; at the homogeneous stage the protoplasm acquires an extreme perviousness to liquid, due probably to the temporary loss of the resistant layers as continuous layers; this stage is accompanied by a loss of turgidity, and in many cases by a marked contraction of the sporange. The clear spaces seen in the final separation are merely the watery liquid of the sporange, and do not represent expulsive matter; there is no evidence of the existence of the expulsive matter in the spore of any aquatic fungus, where the physical conditions are altogether different from those of the aerial ascus of the higher fungi. *Achlya* has been found to be diplanetic or to have the two tractella seen in *Saprolegnia* and *Leptomitus*. The escape of the zoospores is due to the chemical stimulus of the oxygen acting on the automotile zoospores. The author's observations were chiefly made on plants grown on mealworms in tumblers, and floated out on large glass slides for examination.

Aspergillus.‖—Herr O. Johan-Olsen describes all the species of *Aspergillus* hitherto found in Norway, with several fresh observations on their structure. He regards the various forms of sterigma as furnishing no satisfactory specific characters, *A. niger*, *albus*, and *flavus* having both forms. *A. fumigatus*, *flavescens*, and *subfuscus* develope involution-forms within the bodies of animals, the swollen spores putting out numerous spiny or club-shaped, swollen or branched protuberances united into tufts,

* Rev. Mycol., viii. (1886) pp. 5–14, 65–80, 129–36.
† Le Naturaliste, 1886, pp. 1–6. See Rev. Mycol., viii. (1886) pp. 108–9.
‡ See this Journal, 1884, p. 790.
§ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 427–38.
‖ Christiania Vidensk.-Selsk. Forhandl., 1886, p. 25. See Bot. Centralbl., xxix. (1887) p. 292.

reminding one of *Actinomyces*. These resemble the tubercular bacilli in their behaviour towards reagents, and in their pathogenic properties.

The following species are then described:—(1) *A. glaucus* Mich.; (2) *A. flavus* Bref.; developes involution-forms; *A. Oryzæ* is probably only a variety; (3) *A. fumigatus* Fres.; the involution-form causes maladies of the lungs and kidneys; (4) *A. clavatus* Desm.; not pathogenic; (5) *A. niger* van Tiegh.; pathogenic, causing diseases of the skin and breasts, but no internal mycosis; (6) *A. subfuscus* n. sp.; found within putrescent organic bodies, producing in living animals a general mycosis; (7) *A. albus* Wilh.

Development of Gymnosporangium.*—According to Prof. W. G. Farlow, the identity has now been established of *Gymnosporangium claviceps* (on *Juniperus virginiana*) with *Rœstelia aurantiaca* (on *Amelanchier canadensis*), of *G. clavariæforme* (on *J. communis*) with *R. lacerata* (on *Cratægus tomentosa*), of *G. conicum* with *R. cornuta*, and of *G. biseptatum* with *R. botryapithes*. *G. clavipes* occurs also on *J. communis*. Prof. Farlow also believes *G. Ellisii* to be a form of *R. transformans*, and *G. macropus* of *R. penicillata*.

Gymnosporangia and their Rœsteliæ.†—Mr. R. Thaxter, following up Prof. Farlow's paper, communicates the results of further studies on *Gymnosporangia* or cedar-apples and their relation to *Rœsteliæ*. The cycle of development in these fungi is first summarized, and a detailed account is given of the experiments by which the life-history was traced. An attempt is then made to elucidate the difficult problem of the relation of the various species of *Gymnosporangium* to their respective *Rœsteliæ*. The cycle verified by Mr. Thaxter was as follows:—At maturity, towards the close of spring, the cedar-apple consists of sporiferous masses growing from the distortions caused by the mycelium on the stem or leaves of the host. When moistened the masses expand and soften; the spores germinate and form hyphæ (promycelia); these form secondary spores or sporidia; these are carried by the wind from the juniper, cypress, &c., to certain Pomeæ, where they form *Rœsteliæ*. On the new host the sporidia germinate, entering the tissues and causing discoloration. Flask-shaped cavities (spermogonia) appear on the surface, and within these are formed minute bodies or spermatia of doubtful function. Opposite these, on the under side of the leaves, or in the same position with them in young shoots or fruits, cup-shaped æcidia are formed, and within these successive sets of spores surrounded by the membranous capsule or peridium. On the rupture of this the liberated spores are carried by the wind to cedars where they reproduce cedar-apples. No definite results were obtained for or against the theory that the spermatia are sexual and fertilize a female "trichogyne" which gives rise subsequently to the æcidium.

New Pythium.‡—Under the name *Pythium anguillulæ aceti*, Prof. R. Sadebeck describes a new species which attacks the vinegar-eel, kills it in a short time, and then developes luxuriantly in its dead body. In differs in no essential respect from the other species of the genus. The conidia and oogones are, however, produced contiguously and at nearly the same time, and the number of conidia is very large; they usually germinate directly, without the production of zoospores; the oogones and conidia are smaller than in other species of *Pythium*.

* Bot. Gazette, xi. (1886) p. 234. Cf. this Journal, 1881, p. 774.

† Amer. Acad. of Arts and Sci., Dec. 1886. Cf. Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) pp. 429–34.

‡ SB. Gesell. Bot. Hamburg, Feb. 25, 1886. See Bot. Centralbl., xxix. (1887) p. 318.

Structure of Ravenelia.*—Mr. G. H. Parker finds *Ravenelia glandulæformis* abundantly on both sides of the leaves of *Tephrosia virginiana*, especially the under side. The hyphæ form a kind of hymenium in cavities beneath the epidermis, from which the uredospores are separated by abstriction, and escape through a perforation in the epidermis. Then appear the teleutospores, the mass of which fills the entire opening. Uredospores are formed only on the leaves, teleutospores also on the rachis and young parts of the stem. The teleutospores are very large, and consist of a stalk, on which is formed the so-called "cyst," and from this the mass of spores as an outer layer, the inner mass of cyst-cells having apparently no function except the dispersion of the spores. The spores are either uni- or bilocular. In *R. indica* the spores are unilocular, and each is not borne on its own cyst-cell, but, at the margin, each cyst-cell bears two or three spores. There are two types of teleutospore in the genus, one represented by *R. glandulæformis*, the other by *R. indica*.

Rhizoctonia.†—According to Prof. E. Rostrup, the mycelium of the *Rhizoctonia* of clover is essentially epiphytic. It is composed of creeping and branching hyphæ, with thickened septa, the thickness of which varies from 2–5 μ. On the part of the root which is coloured with this red mycelium numbers of blackish-red warts are to be found, formed of interlacing hyphæ which resemble unripe perithecia, without thecæ or spores. *Trifolium hybridum* often lives some time after the root has been destroyed by the fungus, putting out from the lower part of the stem numerous adventitious roots; and in this case the rose-coloured mycelium frequently extends above the soil upon the stem and the lower stipules. The tubercules, which by old writers were noted as one of the characteristics of *Rhizoctonia*, are few in number in the species parasitic on the clover. As for the warts, which, in the form of dots, cover the roots attacked, they have a diameter of 0·1 mm., and are placed very close together. Even under the Microscope they are a deep red. Several times, in the case of *hybridum*, the author found, on the attacked roots of the preceding autumn, warts developing pycnidia filled with numerous stylospores; on the red sclerotic tubercules of the roots of *Trifolium* and *Medicago* he also determined the presence of conidia. Perithecia and thecæ he failed to discover.

Rhopalomyces.‡—M. J. Costantin describes a new species of this genus, *Rhopalomyces nigripes*, growing on *Peziza arenaria*. He suggests the removal from the genus of all the species, such as *R. candidus*, with an uncoloured septated pedicel terminated by a sphere covered with hyaline spores; these he considers, should be relegated to *Œdocephalum.*

Sphæropsideæ, Melanconieæ, and Hyphomycetes.§—The 3rd and 4th vols. of Dr. P. A. Saccardo's 'Sylloge Fungorum' are occupied by a monograph of these three families. It having been shown that all hyphomycetous fungi are but stages of development of species belonging to a higher class, the conidial and pycnidial forms of many Pyrenomycetes and Discomycetes are described under the Hyphomycetes and Sphæropsideæ.

The Sphæropsideæ are divided into four forms, viz. (1) Sphærioideæ, with seven sections based on the character of the spores, viz. *Hyalosporæ*, *Phæosporæ*, *Phæodidymæ*, *Hyalodidymæ*, *Phragmosporæ*, *Dictyosporæ*, and *Scolecosporæ;* (2) Nectrioideæ, with two subcohorts, *Zythieæ*, with four

* Proc. Amer. Acad. Sci., xxii. (1886) pp. 205–18 (2 pls.).

† Overs. K. Danske Vid. Selsk., 1886, pp. 59–76 (2 pls.) and ix.–xiii. (French résumé).

‡ Bull. Soc. Bot. France, viii. (1886) pp. 489–93.

§ Saccardo, P. A., 'Sylloge Fungorum,' vols. iii. and iv., 1885, 1886.

corresponding sections based on the nature of the spores, and *Patellineæ*; (3) LEPTOSTROMACEÆ, with four, and (4) EXCIPULACEÆ, also with four corresponding sections. The Melanconieæ are divided into six sections, also founded on the characters of the spores. The Hyphomycetes are classed under four families, viz. (1) MUCEDINEÆ, with five sections, *Amerosporæ*, *Didymosporæ*, *Phragmosporæ*, *Staurosporæ*, and *Helicosporæ*; (2) DEMATIEÆ, with corresponding sections; (3) STILBEÆ, with two parallel series, *Hyalostilbeæ* and *Phæostilbeæ*; and (4) TUBERCULARIEÆ, with two series, *Tubercularieæ mucedineæ* and *dematieæ*.

New Fungoid Disease of Barley.*—Herr J. Eriksson describes a disease which is very destructive to barley in the neighbourhood of Stockholm, making its appearance as brown spots on the leaves, extending to the whole surface, preventing the production of ears, and finally killing the plant. He believes it to be produced by *Helminthosporium gramineum*.

New Disease in Corn.†—M. G. Passerini states that June 1883, M. Rignoni noticed, at Vigatto, that the corn stubble was covered with a cryptogamic growth. The parasite showed itself at the first node on the culm, and covered the sheath of the leaf and then the leaf itself with greyish spots, interspersed with black spots arranged in a longitudinal row in the parenchyma. A fresh attack of the same disease was noticed by the author in June 1886, at Torchiara, near Parma. This was investigated, and it is stated that the parasite which caused it is a new *Sphæria*. It has been taken as the type for a new genus, and has been called *Gibellina cerealis* Pass.

Structure and Life-History of Phytophthora infestans.‡—Prof. H. Marshall Ward, having been instructed by the Science and Art Department to prepare a series of drawings illustrating the structure and life-histories of certain parasitic fungi, here gives those which deal with the potato fungus; the remarks with which they are accompanied form a connected life-history.

Protophyta.

Lower Forms of Animal and Vegetable Life.§—M. P. A. Dangeard discusses the relationship towards one another of the Protozoa and the Chytridineæ, placing in the former class those organisms in which the food-materials are digested in the interior, in the latter those in which digestion takes place from the outside. Among the former he treats especially of the Vampyrelleæ, of variable form, the protoplasm of which never contains a nucleus, but a large number of reddish granulations; from the surface protrude a large number of filiform retractile pseudopodia. The food-material is sometimes swallowed for digestion; sometimes the cell-wall is pierced and the nutriment extracted. The Vampyrelleæ frequently divide during their period of activity; conjugation is rare; a variable number may unite into plasmodia. The sporangia are usually formed at the close of the period of activity; their cell-wall is composed of cellulose, and they give birth to zoospores. A production of cysts or resting forms also takes place when the conditions of life are unfavourable.

A number of species of *Vampyrella* are described, and it is proposed to sink in this genus Klein's *Monadopsis*. Nearly allied to the Vampyrelleæ are the heliozoarian Rhizopods, and descriptions are given of various species

* Bot. Sällsk. Stockholm, Feb. 17, 1886. See Bot. Centralbl., xxix. (1887) p. 91.
† Rev. Mycol., viii. (1886) pp. 177–8.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 413–25 (2 pls.).
§ Ann. Sci. Nat. (Bot.), iv. (1886) pp. 241–341 (4 pls.).

belonging to the genera *Nuclearia*, *Heterophrys*, and *Actinophrys*. Next come the zoosporous Monadineæ, of which the genera *Pseudospora*, *Barbetia* n. gen. (*Pseudospora Volvocis* Cnk.) and *Soretia* are treated. In this family should be placed *Chytridium destruens* Now.

The family most nearly allied to the Vampyrelleæ of an undoubtedly vegetable character are the Chytridineæ. Their close alliance to the Flagellata is confirmed by the discovery of a new genus of Chytridineæ carrying on a parasitic life within *Euglena viridis* and other Flagellata and Rhizopods, to which M. Dangeard gives the name *Sphærita*. It occurs in the form of large spherical masses which break up into zoospores which escape by the rupture of the wall of the host; each zoospore has a long strongly curved cilium placed in front. The author gives a series of reasons for concluding that these organisms cannot be endogenous reproductive germs of the host. Cysts are formed, but only very rarely. The nearest relationship of *Sphærita endogena* is with *Minutularia* (*Chytridium*) *destruens*, from which it differs in scarcely any other point but in its mode of nutrition.

Sphærita the author regards as the lowest member of the Chytridineæ; next to it come *Olpidium* and *Olpidiopsis*. *Olpidium apiculatum* Br. is the early stage of a *Rhizidium; O. zootocum* Br. is identical with *Catenaria Anguillulæ* Sorok., and should be placed among the Ancylisteæ. Then follow descriptions of the genera *Chytridium* and *Rhizidium*, with some of their species.

The Ancylisteæ are allied to the Chytridineæ through *Catenaria;* while *Ancylistes* leads, on the other hand, to the Peronosporeæ; *Pythium dichotomum* sp. n. appears to be a sexual phase of *Catenaria*. The cycle of development of *Ancylistes* is completed by the germination of the oospores.

Structure of Nostochineæ.*—In a general review of the structure of the Nostochineæ (Nostocaceæ, Rivulariaceæ, Oscillariaceæ, Scytonemaceæ, and Stigonemaceæ), Sig. A. Borzì states that the gelatinous sheath which invests each filament is reduced to very small dimensions in *Oscillaria*, and is entirely wanting in *Borzia*. The number of cells of which the hormogones consist is very variable, and may be reduced to two; in a few species only is it constant, viz. three in *Borzia trilocularis*, four in *Dactyloglœa prasina* sp. n., eight or sixteen in *Seguenzæa*, an undescribed genus of Stigonemaceæ. The hormogones are either perfectly straight or spiral, the former moving in a straight line, the latter describing with their apices a helicoid curve. This difference is accompanied by special biological peculiarities.

The straight homogones are always entirely destitute of any gelatinous sheath, as in *Lyngbya*, *Plectonema*, the Nostocaceæ, Scytonemaceæ, Rivulariaceæ, and Stigonemaceæ; while those that are spiral are clothed in a very thin transparent sheath, as in *Spirulina*, *Oscillaria*, and *Microcoleus*. The spiral torsion is especially strongly displayed in *Spirulina*. Spiral hormogones are specially characteristic of terrestrial species.

For the gelatinous substance of those cells which are in a resting condition, viz. spores and the constituent cells of hormogones, the author proposes the term *cyanophycin*. He states that, from a physical and chemical point of view, it is identical with the gelatinous substance in which the filaments themselves of the Nostochineæ are enveloped, and believes it to originate from the walls of the cells; it is probably a ternary substance allied to starch. The colouring of the cell-contents is not due to the presence of chromatophores; in *Nostoc ellipsosporum* he was unable to detect any nucleus, or only a very rudimentary one. A distinct connection from cell to cell by means of very fine threads of protoplasm or of cyano-

* Malpighia, i. (1886) pp. 74-83, 97-108, 145-60, 197-203 (1 pl.).

phycin can be demonstrated in many species of *Nostoc*. This intercommunication between the cells is always interrupted on the formation of heterocysts. During the transformation of ordinary cells into heterocysts, the walls become thicker, the cellulose-like substance collecting especially round the pores through which the strands pass, and eventually altogether closing them. The cells of the hormogones present the same peculiarity of structure.

Cells which are about to change into spores cease dividing transversely, and increase slightly in size; the contents become slightly darker in colour, and the gelification of the outer layers of the cell-wall ceases. The spore is the result of a true process of rejuvenescence, its cell-wall being formed, not from that of the old cell, but out of its contents. The mature spore possesses a distinct outer layer or exospore. The spores thus formed are true examples of cystidia.

Intercellular communication can be detected also in the Scytonemaceæ, Stigonemaceæ, and Rivulariaceæ, which present no difference, in other points of physiological importance, from the Nostocaceæ.

The Oscillariaceæ are conveniently divided into two groups, according as their movement is straight or spiral. Of the latter class *Oscillaria* may be regarded as the type. Contrary to the general statement, the author finds the filaments to be always invested in a delicate gelatinous sheath, which can be readily seen on treatment by alcohol. There is no sharp differentiation between the cell-wall and protoplasmic contents, the former being but a slightly differentiated peripheral portion of the latter. *Lyngbya* and *Microcoleus* present the same structure as *Oscillaria*. The helicoid motion of the filaments of *Oscillaria* is due to the axis of the filaments never being perfectly straight; the form and direction of the apical portion always differ from that of the main portion of the filament; and this apical portion is always protected by a kind of cap. In the case of those species which live associated in dense tufts, the motion is incessantly interrupted and altered in a variety of ways. The direction of the motion is strongly affected by light; but the author states that it is an error to suppose that this motion is constant at all periods of development of the filaments. It is confined to the reproductive period, when the colony is multiplying and extending its geographical area by the production of hormogones.

Heterocystous Nostocaceæ.*—Under this name, MM. E. Bornet and C. Flahault include all the Phycochromaceæ (Cyanophyceæ) which are reproduced by hormogones, and in which the cells are of two distinct kinds, ordinary vegetative cells;—and special cells, terminal hair-like cells or heterocysts, i. e. the Rivulariaceæ, Sirosiphonaceæ, Scytonemaceæ, and Nostoceæ. The structure of these families is described in reference to the cells, the trichomes, the sheath, the heterocysts, the branching, the hormogones, and the spores.

The authors have been unable to detect the presence of a distinct nucleus in any one species. The cells attain their highest degree of differentiation in the Rivulariaceæ. They propose to limit the term "trichome" to the row of cells or masses of protoplasm, "filament" to the trichome with its gelatinous envelope. The gelatinous sheath, when thick, often consists of a system of lamellæ, crossed by transverse lines or folds, resulting from the extensibility of the integument of the cell, and the different capacities for gelification of its layers. Heterocysts occur in all the forms except a few species of Rivulariaceæ; they may be larger or smaller than the vegetative cells. In certain Rivulariaceæ (*Rivularia, Calo-*

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 323–81; iv. (1886) pp. 343–73.

thrix scopulorum, &c.) the authors find a kind of reproductive cells, which they call *conidia*, differing from ordinary spores in preserving the appearance of the vegetative cells, and multiplying indefinitely in the manner of *Chroococcus*.

The rest of the present instalment of the paper is occupied by a monograph of the Rivulariaceæ contained in the different French herbaria, which the authors divide into three subtribes, Leptochæteæ, Mastigotricheæ, and Rivularieæ, and ten genera, viz. *Leptochæte*, *Amphithrix*, *Calothrix*, *Dichothrix*, *Polythrix*, *Sacconema*, *Isactis*, *Rivularia*, *Glœotrichia*, and *Brachytrichia*. Of these *Polythrix* and *Isactis* are exclusively marine, *Glœotrichia* exclusively fresh-water; the other genera comprise both marine and fresh-water, including five brackish species. The total number of species described is 59, of which several are now described for the first time.

Effects of Solar Light on Bacillus anthracis.*—M. S. Arloing, who has already announced that spores of *Bacillus anthracis* sown in small quantities in a clear culture-solution are killed by two or three hours' exposure to the sunlight of June or July, notices the criticisms that have been made by MM. Nocard, Duclaux, and Strauss, and then gives an account of the later experiments which he has instituted. He finds that under conditions in which it is impossible for a mycelium to arise, the spores sown in the fluid are sterilized by the sun in a short time, which varies with the season of the year. The sun does destroy the spores placed in water, but it only does so after a longer period of time than is necessary to effect their death in a suitable fluid such as soup. Further investigations are necessary to determine the influence of liquid screens interposed between the spores and the sun; and to these the author intends to devote himself. What has been done is sufficient to give a hint as to the application of the results to hygiene; it would be well to expose to the rays of the sun, without any shelter, regions where the spores of micro-organisms have been deposited.

Bacillus Brassicæ.†—Dr. G. Pommer found in decoction of cabbage leaves, in addition to *Bacterium megatherium* and other small Bacteria, a Schizomycete characterized by mycelia in its vegetative condition, and which is propagated by endogenous spores inclosed, after germination, in a distinct spore-case.

The vegetative forms derived from cultivation show more or less distinct markings along the course of the mycelia, the thickness of which is 0·00091–0·0012 mm. The sparseness or closeness of the sowing and the consistence of the nutritive medium appeared to exert some influence on the form of the mycelium. If thinly sown, straight or wavy lines of threads without loss of continuity are developed; but when more closely packed, the lines become more curved and spiral. Cultivation on agar-agar produced straight bundles of filaments, while within the medium tortuous masses of straight, wavy, and short threads were formed. Deprivation of air was found to be a principal cause of involution, and occurred in the worn out and spore-forming filaments. In the latter case a complete disappearance of the protoplasm took place; in others, changes occurred in the plasma, together with swelling up of the membrane. Spores originate only with access of air, and at first appear as greyish balls. Fully formed spores are oval, being about 0·0009 mm. broad, and from 0·0012–0·0015 mm. long. At a temperature of 33° C. they are formed in sixteen to twenty-four hours; at ordinary temperature, in double the time. In a short joint there is one spore; in the larger ones sometimes two, and their position is usually terminal. As the spore germinates, it increases

* Comptes Rendus, civ. (1887) pp. 701–3.
† MT. Bot. Inst. Graz, i. (1886) pp. 93–112.

considerably in size, and after rupture of the membrane a rod-like form appears. This happens at 33° C. in $1\frac{1}{4}$–$1\frac{1}{2}$ hours. The germs grow in a straight or curved direction with terminal increase, but with very variable degrees of rapidity. In no stage of development was there any evidence of motility. White mice injected with or fed on the spores were unaffected. For this Schizomycete the author has proposed the name *Bacillus Brassicæ*.

Bacterium of Wheat Ensilage.*—In an examination of wheat ensilage, Dr. O. Katz found three kinds of bacterium and two kinds of mould. One peculiar bacterium is described, having the form of *Streptococcus*. The bacteria were cultivated on gelatin plates, and this particular form showed itself as yellowish-white colonies amongst the others, the outline being crenate; and as growth proceeds, they form white patches, the centre of which is depressed. The chains of micrococcus-like forms stain intensely with methylene-blue, &c. Cultivated in test-tubes, liquefaction takes place in a funnel-like manner around the needle path, being especially active on the surface. Ultimately the whole is liquefied. The bacterium readily grows on sterilized potato. The growth of the *Streptococcus* is accompanied by a sour smell.

History and Biology of Pear Blight.†—Mr. J. C. Arthur enumerates the various theories and hypotheses that have been put forward as to the nature of pear blight. In 1877 Professor Burrill first observed the bacteria of blight. In 1882 he characterized the organism under the name of *Micrococcus amylovorus*. The form of this species of bacterium is very constant under all conditions. The single cells are from oval to roundish-ovoid, and only vary by slight changes in the ratio between their length and breadth; being from 1 to $1\frac{1}{4}$ μ long, by 1/2 to 3/4 μ broad, and quite colourless. For the most part they exist as single independent cells, but may often be found in pairs, especially when still multiplying, and in rare instances are united into a series of four or even more, but never extend into chains.

By far the most characteristic feature of the life-history of *M. amylovorus* is the formation of zooglœa-colonies. These have never been observed in the tissues of the tree, under any conditions, or in or upon any sort of solid medium, but they occur with much regularity in fluid cultures, when placed under favourable conditions for rapid growth. The range of substances which may serve as culture media is very wide; that which on the whole has proved most satisfactory in an infusion of potato. This is prepared by digesting a pared potato in three or four times its bulk of water over a water-bath for a couple of hours. If the heat is allowed to rise much above 70° C., the starch is gelatinized, and it is only with difficulty that the solution can be filtered. Another equally good culture fluid is made by treating corn (maize) meal in a similar manner. The solution is colourless, but it is apt to throw down a troublesome sediment. An infusion of hay gave a nearly normal growth of blight bacteria, but the cells were considerably more refractive than usual.

As to its behaviour towards staining fluids, the most successful results have been obtained with an aqueous solution of Bismarck-brown, especially in cover-glass preparations. What chemical changes are brought about by its activity in the plant cannot be definitely stated, further than to say that a mucilage or gum, which is soluble in water, is produced in abundance, with the disengagement of carbon dioxide.

Bacterium of rotten Grapes.‡—Sig. L. Savastano dissents from the view that the disease of the grape which has been so wide-spread during recent

* Proc. Linn. Soc. N. S. Wales, i. (1886) pp. 925–8 (1 pl.).
† Proc. Acad. Nat. Sci. Philad., 1886, pp. 322–41.
‡ Malpighia, i. (1886) pp. 175–83. See this Journal, *ante*, p. 129.

years is due to *Phoma uvicola*, to *Peronospora*, or to "black rot." Whether the rottenness be dry or moist, he was able to detect, with sufficient enlargement (600 diams.), the invariable presence of a special bacterium, for which, however, he does not propose any specific name, but was able to cultivate it on peptonized and sterilized gelatin. The difference between dry and wet decay he attributes to the state of the berry and of the atmosphere, the former appearing especially on green, the latter on ripe grapes. The leaves of the grape-vine have been described by Viala and Ravaz as being also subject to the attacks of a bacterium, which is probably identical with that of the berry, though this has not been demonstrated.

Destruction of Pathogenic Schizomycetes in the organism.*—Herr Ribbert states that after the injection of small quantities of spores rabbits do not die but remain healthy. From the examination of the organs at various intervals after injection, it was found that a regular germination of the spores did not occur. After six hours they were found, especially in the liver, to be surrounded by leucocytes. The collection of white corpuscles, among which the spores were destroyed, in some few days led to the formation of small nodules, dilatation of the capillaries, and compression of the liver cells. With the death of the fungi the leucocytes disappeared, the liver cells recovered frequently with the formation of giant cells, which often contained spore-remains. In the lungs, also, giant cells were formed from the endothelia, and these also took up the fungi. In both organs the spores only came to an imperfect germination like a fine radiation, their regular development being hindered by the protoplasmic investment chiefly produced by the leucocytes.

Lepra Bacilli.†—Dr. P. Guttman, from frequent examinations of a case of lepra occurring in a girl twelve and a half years of age, was able to confirm the observations of previous writers. Unstained bacilli examined in distilled water, with 1/12 oil-immersion, showed lively movements both when within the cells and when lying free without. When stained the bacilli were found to behave as previously reported by Neisser and Koch. The author is of opinion that lepra bacilli stain more quickly than those of tubercle, and as a point in the differential diagnosis of these two from cover-glass preparations, he remarks that lepra bacilli are very often found within the cells, while those of tubercle are rarely or never seen in similar situations.

Micro-parasite of Variola.‡—Dr. A. Marotta has found that there constantly exists, in the lymph of the variola vesicle which has not yet suppurated, a specific micrococcus. This occurs as tetrads. After suppuration other cocci appear; these are, for the most part, the *Micrococcus albus*, which greatly resembles the micro-parasite described by other authors.

This micrococcus (tetrad) is easily cultivated in nutritive gelatin and in agar rendered alkaline, in coagulated ox-serum, on boiled egg, but not on potato. It seems to flourish best on decidedly alkaline media. The colonies are of an orange-yellow colour, thick, and raised above the level of the nutritive medium. As inoculations made on calves, even with the seventh generation of the culture, produced pustules perfectly identical with those of vaccinia, Dr. Marotta draws the conclusion that this tetrad form is the specific micrococcus of variola. Inoculations of dogs gave only negative results. As subcutaneous injections did not produce any specific lesion, the inference is drawn that the tetrad coccus has nothing in common with pyogenic cocci.

* Bot. Centralbl., xxviii. (1886) p. 396. (Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, 1886.)
† Berl. Klin. Wochenschr, 1885, No. 6.
‡ Atti R. Accad. Lincei—Rend., ii. (1886) pp. 246–7.

Micro-organisms in the Atmosphere.*—Dr. P. F. Frankland describes a new method by means of which he claims that the estimation of organisms in the air can be more accurately obtained.

A known volume of air is aspirated through a glass tube containing two sterile plugs, the first of which is more pervious than the other. The two plugs are then transferred to two flasks, each containing melted sterile gelatin-peptone, and plugged with sterile cotton wool. The plug is carefully agitated, and when it has become disintegrated and mixed with the gelatin, the latter is congealed, so as to form an even film over the inner surface of the flask. The flasks are incubated at a temperature of 22° C., and after four or five days the colonies derived from the organisms contained in the plug make their appearance.

The process possesses all the advantages of a solid medium. The results are not affected by aerial currents. The collection of an adequate quantity of air takes but little time, so that a much larger volume can be examined than by Hesse's method. The apparatus, being very simple, can be used where there is no special laboratory.

Distribution of Micro-organisms in the Air.†—Dr. P. F. Frankland and Mr. T. G. Hart add to their previous experiments with Hesse's apparatus on the prevalence of micro-organisms in the air. The number (per 10 litres of air) varies greatly with the season, e. g. in January, 4, and in August, 105 were found to be present. Experiments in crowded rooms also show the enormous increase in number of micro-organisms; thus in the library of the Royal Society, during a conversazione, as many as 432 per 10 litres were found. By exposing dishes filled with nutrient gelatin, the authors were able roughly to estimate the number of micro-organisms falling on a given horizontal surface.

Micro-organisms of the Soil.‡—Herr B. Frank has examined the living organisms found in various samples of soil taken from localities where there seemed no possibility of their being influenced by human agency. Among the forms found in most of the cultures, but not without exception, were a *Cephalosporium*, a simple *Botrytis*-form, a *Torula*-form, an *Oïdium*, in one case a *Mucor*, and a *Torula*-form with nearly spherical bud-cells. Invariably there was also present, in all the cultures, a Schizomycete, presenting, in all the samples, a similar succession of forms of development. About the second day it made its appearance as a *Leptothrix*, causing the gelatin to deliquesce. The threads collect into an interwoven mass, and then break up into the second or *Bacillus*-form, which increase rapidly or finally divide again by bipartition into the third or *Bacterium*-form of very short rods or oval cells. Within the cells are formed shortly oval, strongly refringent spores, usually one or two near the end of each rod; and these close the series of development. The rods become disorganized and their membrane gelatinized, the spores becoming thus collected into zooglœa-like masses, from which they again germinate in the form of rods. The different forms may be motionless or may display various degrees of motility. The bacilli are frequently curved in a comma-form. This universally distributed microbe of the soil Frank proposes to call, according to its stage of development, *Leptothrix terrigena*, *Bacillus terrigenus*, or *Bacterium terrigenum*. Its closest resemblances are with the hay-bacterium and anthrax.

The best nutrient materials for this microbe of the soil are gelatin and decoction of plums. Pure cultures exhibited no tendency to nitrification, i. e. to the conversion of ammonia-salts into nitrites or nitrates; and the

* Proc. Roy. Soc., xli. (1886) pp. 243–6. † Ibid., pp. 446–7.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886), Gen. Versamml., pp. cviii.–cxviii.

same was the case also with the Hyphomycetes. The author concludes that, although it is possible that, under certain conditions, bacteria may be able to oxidize ammonia, yet the nitrification which goes on in the soil is mainly due to inorganic factors, the power of the soil in this respect being possibly analogous to that of spongy platinum.

Bacteria in the Soil.*—Herr L. Adametz has examined the bacteria and other low fungoid organisms present in the soil, and finds them almost identical, whether the soil be sandy or loamy. Of Schizomycetes he finds *Micrococcus candidus*, *M. luteus*, *M. aurantiacus*, *Diplococcus luteus*, *Bacterium Lineola*, *B. Termo*, *Bacillus subtilis*, *B. butyricus*, *Vibrio Rugula*, and two new bacteria, one of which produces a blue-green fluorescent pigment, and a new bacillus. Of Saccharomycetes there were found *Saccharomyces glutinis*, *Monilia candida*, and red and white torulose cells; of moulds, *Penicillium glaucum*, *Mucor Mucedo*, *M. racemosus*, *M. stolonifer*, *Aspergillus glaucus*, and *Oïdium lactis*. The number of Schizomycetes was estimated by Thoma's apparatus as varying between 400,000 and 500,000 per gramme of soil.

The author was unable to affirm the presence of a distinct bacterium with the power of oxidizing considerable quantities of ammonia into nitric acid; on the other hand he found not unfrequently that they caused a production of ammonia by reduction of nitrates. He regards the function of the moulds, which frequently hibernate in the soil, to be the decomposition of carbohydrates without the production of gases with an offensive smell.

Bacteria in Drinking-water.†—Mr. M. Bolton, in his research, used Koch's plate-culture method, as he found it to be superior to the Fol-Dunant procedure.

From an examination of different waters (spring, pond, &c.), he found, in agreement with Cramer and Leone, that a significant increase of bacteria takes place at first, but that this increase is succeeded, in three to ten days, by a slowly augmenting decrease. He further found that the quality of the water in respect to its organic and inorganic contents was without influence on the increase of water bacteria. A temperature of 1° C. was marked by a diminution in the number of bacteria, while temperatures of 6°, 15°, and 22° C., was followed by a proportional increase. The influence of hydrogen and carbonic acid gases (effected by means of the apparatus employed by Liborius) showed that the former gas was little or no hindrance to development, while CO_2 diminished the developmental activity, or even destroyed it.

The question whether pathogenic bacteria such as *B. anthracis*, *Staphylococcus aureus*, *M. tetragonus*, and *B. entericus*, were capable of propagating themselves in water, was decided in the negative. The disappearance of these organisms showed itself more quickly at higher temperatures (35° C.) than at lower ones (20° C.), and was further dependent on their capacity for specific resistance, and especially whether they were sporiferous or not. The quality of the water made considerable difference; for if nutrient material such as meat infusion were in small quantity, typhoid and cholera bacilli began to multiply.

Bacteria in Water.‡—Dr. G. Wolffhügel and Dr. O. Riedel, from their experiments, arrived at the same conclusions with regard to pathogenic bacteria as Mr. Bolton. They differ, however, from him as to the non-pathogenic forms, inasmuch as their experiments showed that typhoid and anthrax bacilli increased in water when temperature conditions were

* Adametz, L., 'Unters. üb. d. niederen Pilze d. Ackerkrume,' 78 pp. and 2 pls., Leipzig, 1886.

† Zeitschr. f. Hygiene, i. (1886) p. 75.

‡ Arbeit. K. Gesundheitsamte, 1886, Heft 2. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 417–20.

favourable. Cholera bacilli in unsterilized water were found to disappear in a few days, but in sterilized water an initial diminution was followed by a copious increase. The authors also noted that typhoid and cholera bacilli were capable of luxuriant growth in milk.

The method adopted was more minute and fractional than that of Bolton. Inoculations were at first made with platinum wire, and afterwards by means of a capillary pipette, divided into 1/500 cc. If after using 1/500 cc. too many germs appeared on the plate, 5/500 cc. of the infected water was diluted with 200 cc. of sterilized distilled water, and then 5/500 cc. of this fluid used, so that only 5/100,000 cc. of the germ water were sown.

Bacteriological Examination of Water.*—Dr. O. Katz examined the tap-water of Sydney by means of Koch's gelatin plate method. The five forms noted are described as *Bacterium* A, B, C, D, and E. The appearance of the colonies on gelatin plate, in test-tube of gelatin, and on oblique surface of agar-agar, is described and figured. The author notes the greater number of bacteria in the water after rain.

Bacteria in Ice.†—Dr. T. M. Prudden in a series of thirty-two analyses of Croton water found the lowest number of living bacteria to be 57 per cm., the highest 1950; the average 243. His experiments to test the effects of freezing on bacteria, showed that after prolonged freezing a considerable number of the typhoid bacilli remained alive. His method was as follows. Into sterilized test-tubes was put sterilized water mixed with a small quantity of a pure cultivation, the number of bacteria in one cubic centimetre of water having been previously determined. The tubes were then heated to from 14°–30° F. Six species of bacteria were experimented on. (1) *Bacillus prodigiosus;* (2) a short bacillus found in Hudson river water; (3) a slender bacillus common in Croton water; (4) *Staphylococcus pyogenes aureus*; (5) a short bacillus from ice, which is called "a fluorescent bacillus" from its appearance in gelatin; (6) typhoid bacillus. In the case of *B. prodigiosus*, 6300 in a c.cm. before freezing diminished in four days after freezing to 2970; in 37 days to 22, and in 51 days to none. *Staphylococcus*, which were countless before, diminished after freezing for 18 days to 224,598, to 49,280 in 66 days. The number of typhoid bacilli, countless before freezing, was 1,019,403 after 11 days, 336,457 in 27 days, 89,796 in 42, and 7348 in 103 days.

The general conclusions at which Dr. Prudden arrived, are that analysis of water and ice gives evidence of bacteria, many of which are the originators of disease, but the study is too much in its infancy for a definite opinion to be given as to whether the ice or water be suitable or not for drinking purposes, &c.; that the freezing process only partially purifies, the grosser impurities only being removed, and the bacteria remaining to a considerable extent unaffected; that the different species of bacteria show different degrees of vulnerability to cold, the bacilli of enteric fever and the bacteria of suppuration being capable of standing prolonged exposure to a low temperature; that in natural waters there may be a purification up to 90 per cent.; that while filtration destroys noxious and harmless bacteria to an equal extent, the freezing process is more destructive to innocuous than to pathogenic organisms; that there is a much greater number of bacteria in snow-ice and in bubbly ice than in transparent ice, which if taken from certain lakes and ponds is very pure; that the average number of bacteria in ice from all sources is much greater than the standard for ordinary water.

* Proc. Linn. Soc. N. S. Wales, i. (1886) pp. 907–23 (2 pls.).
† Med. Record, 1887, March 26 and April 2, 61 pp.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Burch's Perspective Microscope.†—In 1874, Mr. G. J. Burch "discovered a form of Microscope giving constant magnification along the optic axis, so that the objects were shown by it in microscopic perspective."

By writing $(f_1 + f_2 + \mathrm{H})$ for the distance between two thin lenses, he obtained for the formula of the system

$$\frac{f_2(f_2 + \mathrm{H})u - f_1 f_2(f_1 + f_2 + \mathrm{H})}{\mathrm{H}u - f_1(f_1 + \mathrm{H})} = v;$$

u being the distance from the object to the first lens, and v that from the second lens to the image.

Putting $\mathrm{H} = 0$ in this equation, three things result:—

1. du / dv, which represent the longitudinal magnification, becomes constant, namely—$(f_2 / f_1)^2$;

2. The lateral or angular magnification, f_2 / f_1, is also constant;

3. A picture of an object so magnified, drawn with the camera lucida, when viewed from a distance f_2 / f_1 times less than that at which it was drawn, has the perspective belonging to an object magnified $(f_2 / f_1)^2$ times.

The distance at which the eye must be placed is great, but may be reduced by employing three lenses, the distance between the first and second being $(f_1 + f_2 + f_2 / m)$, and that between the second and third $(f_2 + f_3 + mf_2)$.

If the lenses are nearly but not quite in the afocal position, greater power and a wider field may be obtained; but it is at the expense of the penetration, which may, however, with advantage be limited to the thickness of the object. The instrument offers great advantages for artistic purposes, but lenses or mirrors of specially wide angle are needed for the farther development of the invention.

The optical conditions of a system of two thin lenses at varying distance apart are shown by diagrams.

In diagram 1 the u and v of the formula employed are set off as abscissæ and ordinates, and the curves (which are rectangular hyperbolas) drawn for several values of H. In the afocal position of the lenses, the curve degrades into a line which is a tangent to all the hyperbolas at the point (f_1, f_2). The locus of vertices and locus of centres of these curves being straight lines, and the hyperbolas all touching the point (f_1, f_2), it is shown that the principal foci, principal points, and equivalent focal length for any given position of the lenses, can be found by rule and compasses, without drawing the curve.

In diagram 2 the actual position of the lenses, their principal foci, separate and combined, and the principal points, positive and negative (answering to the vertices of the curves in diagram 1), are plotted down as abscissæ, the values of H on an enlarged scale being taken as ordinates.

Diagram 3 shows the same for two lenses of equal focal length.

Comparison of these two diagrams suggests the employment of the term "pseudo-principal points" for those positions at which the magnitude

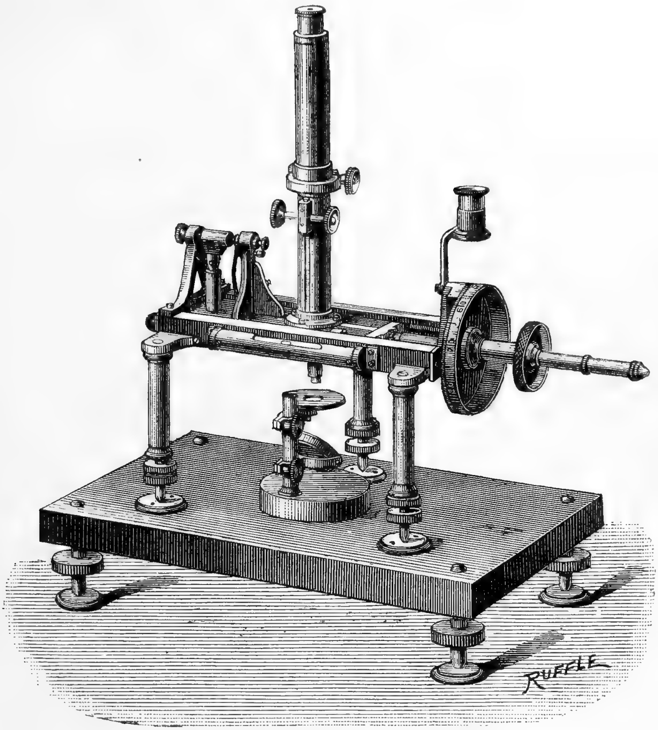
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Proc. Roy. Soc., xlii. (1887) pp. 49–50. See also this Journal, *ante*, p. 288.

of the image is in the constant ratio f_2/f_1 to that of the object for every value of H, inasmuch as the distance from these to the principal points gives the measure of the "penetration" of the system.

Campbell's Micrometer-Microscope.—This (fig. 96) was originally devised by Sir Archibald Campbell for measuring photographs of spectra;

FIG. 96.



it has since been improved for measuring diffraction gratings, and special means have been added for recording end-measurements of standard gauges by utilizing electrical contacts. It is made by Mr. A. Hilger.

It consists of a horizontal metal frame, in which a Microscope is applied to slide over a space of $5\frac{1}{2}$ in. actuated by a micrometer-screw. The frame is supported on three pillars, with adjusting screws for levelling with conical ends fitting in V-slots converging to a common centre, and applied on a substantial iron base-plate standing on adjustable screws, also for levelling.

The micrometer-screw has a pitch of 100 threads to the inch; the drum-head connected with the screw is divided into 100 parts on the edge, and by means of a vernier, direct readings can be taken up to 1/100,000 of an inch. For registering entire revolutions of the screw a fixed scale corresponding with the pitch of the screw is engraved on one side of the frame, and an index-pointer travelling with the Microscope gives the readings.

The diffraction gratings, &c., are carried on an adjustable stage with mirror that can be placed as required on the base-plate under the Microscope.

For standard end-measurements, where the difficulty is to determine the precise points of contact, the object is placed in a double V-carrier, one end touching a fixed electrical contact-point, the other end is then presented towards a travelling contact-point, actuated by the micrometer-screw, and the contact is shown by the deflection of a delicate galvanometer needle to an estimated accuracy of about 1/1,000,000 in. For registering temperatures, a thermometer is attached to the micrometer frame.

In practice the stage-plate on which the object is placed is first levelled by means of a spirit-level, then the tripod of the micrometer-frame is adjusted in the V-slots on the base-plate and accurately levelled, for which purpose spirit-levels are applied to the frame at right angles.

For high-power work the Microscope is furnished with Mr. Hilger's tangent-screw fine-adjustment, in which the motion is unusually slow, and which is described *infra*, p. 461.

Watson-Draper Microscope.—This Microscope (Plate IX.) made by Messrs. Watson & Sons, after the designs of Mr. E. T. Draper, is an elaboration of the instrument suggested by Mr. E. Crossley.* The following description is furnished by Messrs. Watson:—

The idea in arranging it is, that when the object is on the stage, either it may be made to rotate in any direction, horizontal or vertical, round a fixed beam of light, without the light ever leaving the object, or the stage may be kept fixed while the light is revolving round it in any direction, horizontal or vertical; always, however, remaining upon the object. Of course to do this exactly it is absolutely necessary that the object should be precisely in the centre of all the circles in which the various parts of the instrument are revolving, and to enable this to be done with the utmost precision, there is an adjustment to the stage by means of a micrometer-thread screw below, to raise or lower it according to the requirements of different thicknesses of objects.

The body is mounted on an extremely solid pillar carrying a quadrant of a circle, and in this it may be placed in any position from the horizontal to the vertical, and as the stage is connected and moves with the body, and as this arc of a circle is struck from a radius, the centre of which would be the object on the stage, it follows that when light is thrown from directly underneath the object, by inclining the Microscope through this arc and without touching the mirror, the light becomes more and more oblique, till it arrives at that point where it is impossible for it to enter the objective. Again, the stage being a concentric rotating one, allows the object to be moved horizontally round the same fixed light. The two motions therefore are used when it is desired to place the object in any position with regard to a ray of light.

For those objects, however, which could not be conveniently moved, there is another arrangement for keeping the object stationary, while the light is thrown upon it from any desired angle. This is done by using Mr. Crossley's arrangement of a train of prisms transmitting the light on to the mirror and rotating on an axis in the same plane with the object on the stage. The prisms have also an additional movement which Mr. Crossley's arrangement has not, viz. the pillar supporting them is fixed upon a horizontal rotating base-plate so that by the movement of the base-plate, combined with the swinging motion of the prisms, the light may be thrown through them upon the object from any direction, horizontal or vertical. A lamp is fixed permanently to the pillar carrying the prisms, which moves with it in whatever direction it is placed. There is also a

* See this Journal, 1881, p. 653.

Watson-Draper Microscope.

second lamp supplied for illuminating opaque objects from both sides of the instrument, so as to avoid the influence of shadows. The whole of the circles in which the various parts of the instrument revolve are graduated to degrees so that the observer may be able to tell the angle at which any effect has been produced in order that it may be at once obtained again.

The substage and mirror are attached to the prism-box, and move with it. The mirror can also be detached and applied to the centre of the base.

The stage can be raised and lowered to compensate for the different thicknesses of the slide.

Universal Projection Apparatus for Mineralogical Purposes.* — Dr. F. J. P. van Calker's apparatus is announced under the title of "Universal projection apparatus for the representation of microscopical images of thin slices of rocks with and without polarization, of the phenomena of thick and thin crystal plates in parallel and convergent polarized light, of tension phenomena, of the difference between parallel and oblique extinction, the phenomena of pleochroism and microchemical reactions." It is, however, nothing more than a stand with a brass ring, through which crystallographic, optical, and microscopical apparatus are pushed.

Culpeper's Simple and Compound Microscopes (Wilson's form).—The Microscope shown in fig. 97 (simple) and fig. 98 (compound) would appear

FIG. 97.

to have escaped the notice of the writers who have treated of the history of the construction until quite recently.† It was designed and made by Edmund Culpeper whose name is generally known in connection with the

* Zeitschr. f. Krystallogr., xii. (1886) pp. 55–8 (1 pl.).

† Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, pp. 34–5 (2 figs.).

vertical tripod form of Microscope that was so popular from 1738 down to the end of the century. From the fact that no example which we have seen of this instrument was furnished with a Lieberkühn, we think it was probably constructed before 1738.

In fig. 97 the peculiarities are (1) the application of a ball-and-socket inclining movement on a pillar and tripod, to Wilson's "Screw-barrel" Microscope, (2) the addition of an articulated arm to carry a condensing lens, for opaque objects (as in fig. 97), or a plane mirror (as in fig. 98). For opaque objects the lens was removed from the body-tube and a disc having a pivoted arm terminating in a ring substituted. A low-power lens in a horn mount was then screwed in the ring and was thus held at some distance from the instrument so that the object could be properly illuminated.

In fig. 98 the compound body of ivory with draw-tube is shown, also the

Fig. 98.

accessory apparatus. On the left are four simple lenses in disc-mounts; the ivory handle for the "Wilson," when unscrewed from the ball-and-socket, having a screw-box at the end for discs of talc and rings; the forceps-carrier; a diaphragm for the condenser (which is a bi-convex lens in a cell at the lower end of the "Wilson"); hinged animalcule cage with four concave discs of glass, mounted in apertures in a plate on which a similar plate with four corresponding apertures and plane discs is hinged to open or close; condensing lens for opaque objects; carrier with horizontal rotating and vertical pivot movements for the low-power lens in horn cell,

&c.; glass tube for aquatic objects, and forceps. In later constructions Culpeper applied the mirror to one of the feet in a line with the optic axis.

Hilger's Tangent-screw Fine-adjustment. — This fine-adjustment, devised by Mr. A. Hilger, is in principle a direct-action screw, controlled by a worm-wheel and tangent-screw. The mechanism is shown in figs. 99, 100, and 101, and it is applied in the middle of the body-tube.

A is a tangent-screw, actuated by the milled head A′, gearing with a worm-wheel collar B B, having an internal thread by which it engages the screw C C at the upper end of a tube sliding within the body-tube D and carrying the objective at the lower end, the metal stop E preventing

Fig. 100.

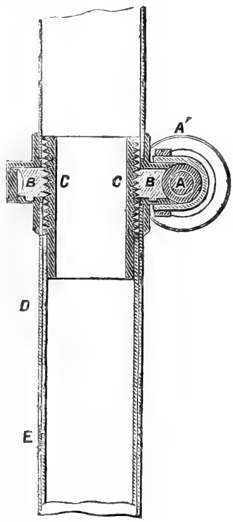


Fig. 99.

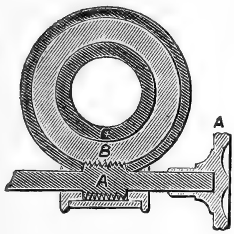
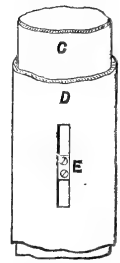


Fig. 101.



lateral movement. B B is fitted in bearings so as to rotate only. The rotation of A moves BB slowly round, causing C C to travel up or down as required in focusing.

Beck & Co.'s Microscopes.

["Apropos of the statement in the December number, that Zeiss had recently issued his 10,000th Microscope, we learn that Beck & Co., London, have manufactured over 14,000."]

The Microscope, VII. (1887) p. 93.

Dippel, L.—**A. Nachet's grosses Mikroskop No. 1 und dessen Objectivform.** (A. Nachet's large Microscope No. 1, and his Objectives.)

[Description of the Microscope described in this Journal, 1886, p. 837.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 457–60 (1 fig.).

Dissecting Microscope, how to make a simple.

[Made out of a crayon box (or a similar one having a sliding lid) with corks, a rod, wire, &c.]

Engl. Mech., XLV. (1887) p. 96, from *N. Gleaner*.

Houzeau, J. C.—**Microscope et Télescope.**

Bull. Soc. Belg. Micr., XIII. (1887) pp. 90–110.

LATTEUX, P.—**Manuel de Technique Microscopique.** (Manual of Microscopical Technique.)

[Cf. *infra*, β (1). In addition to Technique, it contains chapters on Simple and Compound Microscopes, Accessories, Test Objects, Micrometry, Drawing, and Photomicrography.]

3rd ed., xvi. and 820 pp. (385 figs. and 1 pl.), 8vo, Paris, 1887.

Powell's (T.) Microscope and Appendages "made out of odd materials of various kinds." (Mr. Powell is a shoemaker.)

Proc. Lit. and Phil. Soc. Liverpool, No. XXXIX. (1885) p. xlviii.

(2) Eye-pieces and Objectives.

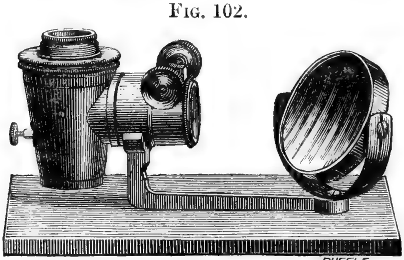
Apochromatic Objectives.*—Dr. M. D. Ewell has examined a Zeiss apochromatic objective, 1/12 in. N.A. 1·40 (with eye-pieces), made from the new optical glass. By oblique light he considers it is a well-corrected objective, but no better than first-class American objectives, except that the images have hardly any perceptible colour. With axial illumination, however, using an Abbe condenser of N.A. 1·40, with no stops or diaphragms whatever, the real superiority of the glass becomes apparent. "I have never before seen so clear and perfect a picture under similar conditions; and it is clearly apparent that the corrections are approximately perfect up to the extreme limit of its aperture. It is not difficult with such axial illumination to resolve a Möller Probe-Platte from end to end, and the images are practically colourless. In the present state of our knowledge, this objective certainly leaves nothing to be desired. The working distance is large, about 1/100 in., and the so-called searcher eye-pieces make even as high a power as a 1/12 very convenient in use. I do not assume to speak for any one but myself; but such, as it seems to me, must be the judgment of any unbiassed observer. For the practical worker with axial illumination, it seems to me that the apochromatic objective is destined to become the objective of the future."

Double Objectives with a common field of view.†—These (made by Herr H. Westien) consist of two lenses or lens-systems, which having been ground away at the edges on one side are placed so near and under such an angle to each other that their optic axes coincide with the axes of the eyes; when this is the case the two fields of view appear united into a single one.

(3) Illuminating and other Apparatus.

Hilger's Opaque Illuminator.—For the illumination of opaque objects to be viewed with Campbell's Micrometer-Microscope, Mr. A. Hilger has devised the apparatus shown in fig. 102, which is a modification of Prof. H. L. Smith's vertical illuminator.

FIG. 102.

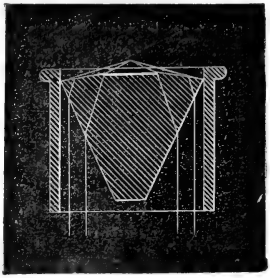


The reflector is concave, of speculum metal, of oval shape, and having a central aperture, through which the rays pass from the objective to the eye-piece. It is mounted in a conical tube, inclined normally 45° to the optic axis, and by means of an adjusting screw this angle may be altered a few degrees, so that the object may be illuminated from one side only if required. A system of condensing lenses with rack-work is applied to direct the light from the external mirror to the speculum, whence it is reflected through the objective and condensed upon the object.

* The Microscope, vii. (1887) p. 63.
† Central-Ztg. f. Opt. u. Mech., viii. (1887) p. 60.

Nachet's Dark-ground Illuminator.—This apparatus (fig. 103) consists of a truncated cone of glass, the base of which has the outer zone ground off to a spherical curve, leaving a central plane disc, which is blackened to exclude light. This cone is mounted in a cylindrical tube, with its base upwards, which is applied in the substage after the manner of the usual Continental cylindrical diaphragms, and racked up close to the transparent object. Parallel rays striking on the conical surface are refracted to the lenticular zone, and thence condensed on the object. M. A. Nachet, by whom the apparatus is constructed, states that "it should be used only with low powers having an angle of aperture less than that of the illuminator."

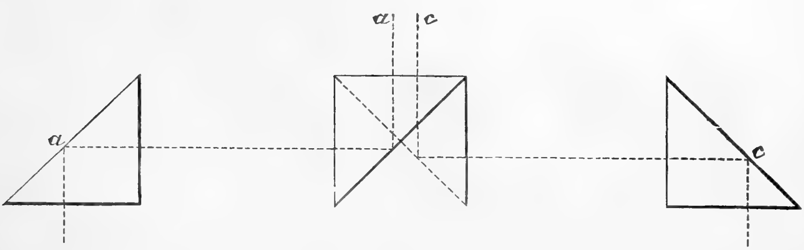
FIG. 103.



Quimby's Lamp-shade.*—Mr. B. F. Quimby's "illuminator" or lamp-shade is intended to be used with the Griffith Club Microscope. It consists of three pasteboard cylinders, accurately fitted one within the other—the external revolving on the middle, the inner being removable. All three cylinders are pierced anteriorly by a round aperture; the middle piece having also a slot. With the inner cylinder removed, the external piece may be twisted one way or the other, the pencil of light coming through the opening thus regulated; or, in the examination of diatoms, the slot may be used. The inner surface of the second cylinder is white, but for the convenience of those who prefer a black background, the inside of the third cylinder is of that colour, and this may be slipped into the illuminator whenever a dark surface is required. The middle cylinder is surrounded at its lower margin with a brass collar, to which a short tube is attached. Into this tube fits the lamp rod, while the illuminator rests on the rod controlling the light.

Van Heurck's Comparator.†—Dr. H. Van Heurck has derived the idea of his comparator from the instrument devised by M. Inostranzeff for comparing the colours of minerals.‡ The latter instrument, though

FIG. 104.

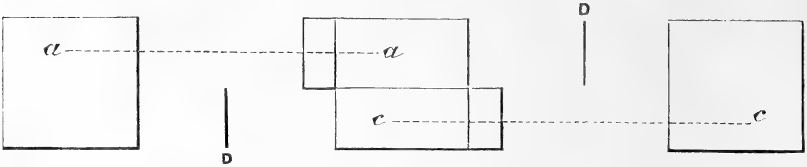


essentially practical, is insufficient for diatoms, as the field is partially intersected and a black band, where the prisms join, prevents perfect approximation. Moreover, it is preferable that the diatoms should be apposed not in their whole length but with half the length of the valve.

* The Microscope, vii. (1887) pp. 56–7.
† Bull. Soc. Belg. Micr., xiii. (1886) pp. 76–8 (2 figs.).
‡ See this Journal, 1886, p. 507.

The new apparatus works perfectly. Instead of two prisms, apposed by their edges, as in Inostranzeff's instrument, there are two prisms of large size, *a*, *c*, figs. 104 and 105, but of slight width and in apposi-

FIG. 105.

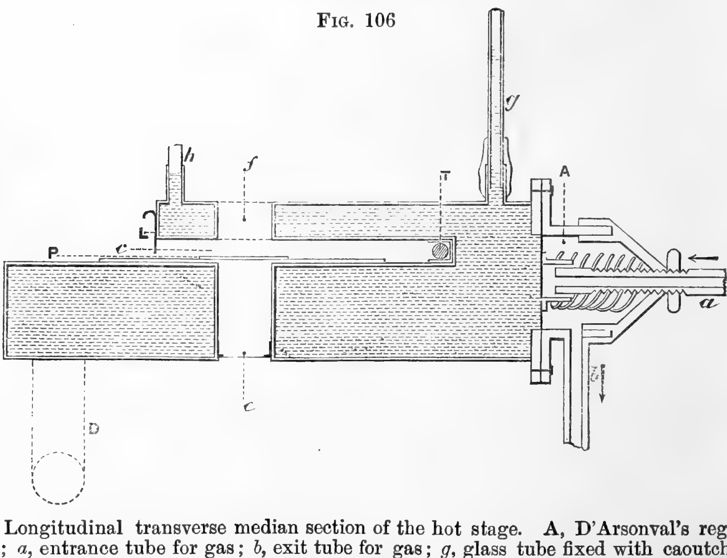


tion by one of their triangular faces. The two images are brought together in the direction of their length: the piece carrying the two prisms is movable, can turn on its axis, and be fixed in any position whatever. By slightly turning it, the line of separation of the two prisms altogether disappears, and so thoroughly, that a perfect valve can be made up of two halves of a valve, each belonging to one of the fields, and the photograph must be examined very attentively to find the place where the valves join.

Thus the comparisons are as complete as possible, and the images so clear that high powers may be used. In each part of the tube the diaphragms D cut off any interfering light coming from the opposite side.

Vignal's Hot Stage with Direct Regulator.*—M. W. Vignal's hot stage (fig. 106) consists of a rectangular brass box open on one side and con-

FIG. 106



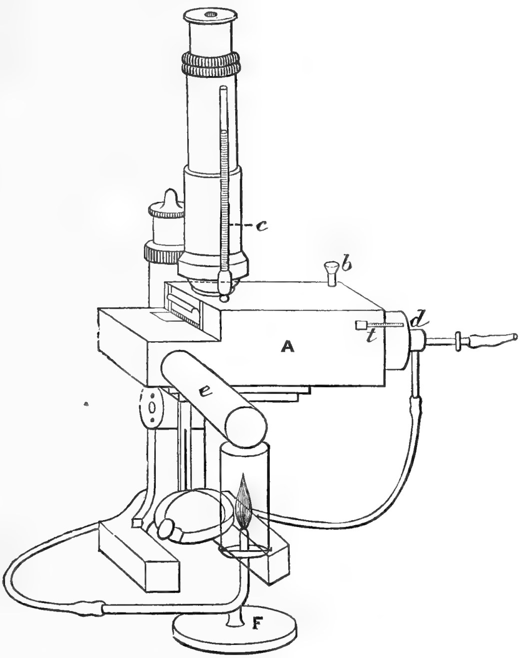
Longitudinal transverse median section of the hot stage. A, D'Arsonval's regulator; *a*, entrance tube for gas; *b*, exit tube for gas; *g*, glass tube fixed with caoutchouc band; *h*, tube for introduction of water; *c*, hot chamber proper, with slide P and thermometer T; L, door closing chamber; *f*, aperture for objective; *e*, glass disc in copper ring for closing the illuminating aperture; D, heating cylinder.

taining a second small rectangular box. These two boxes are perforated by an aperture which allows the light to be reflected upwards from the mirror.

* Arch. de Physiol., vi. (1885) pp. 1–10 (2 figs.).

The lower part of the aperture is closed by a small glass diaphragm, let into a copper ring. On the other side of the large box is fitted D'Arsonval's caoutchouc regulator; on the front side is a cylindrical diverticulum like that of a hot filter. On the upper surface are two brass tubes; to the front one is fixed, by means of a caoutchouc ring, a glass pipe into which the water rises in order to determine the pressure and consequently the regulation of the escape of gas; the other tube, closed by a caoutchouc plug, is that through which the box is filled with water and freed from gas or air. In front another tube passes through the chamber; in this is inserted a thermometer insulated by means of a piece of Bristol board. On the right side of the smaller box is a lateral opening for the insertion of the slide, and as the upper part of the larger box is wanting towards the right,

FIG. 107.



Showing the appearance of the hot stage arranged on the Microscope. A, hot chamber *b*, water tube; *c*, glass pressure tube; *d*, D'Arsonval's regulator; *e*, heating cylinder; F, burner with glass chimney; *t*, thermometer.

the defect serves for the easier manipulation of the slide. The hot stage proper is 5 mm. high, 75 mm. long, and 40 mm. broad, and in order not to lose heat a small door drops down just so far as not to interfere with the slide. The gas burner is inclosed in a glass chimney, in order to keep the flame quite steady.

The apparatus is put in working order as follows: The pressure tube having been arranged, the chamber is filled with boiling water, and is shaken from time to time in order to disengage any inclosed air. The apparatus is then placed on the stage, the gas lighted, and the regulator tap turned down until the flame begins to diminish. The tube is

then screwed up and the gas-jet placed at the end of the heating tube. As the water gets warm its excess escapes from the tube through which it was introduced. In about one hour to an hour and a half, when the thermometer marks 36° to 38° C., the tube is closed with the caoutchouc plug. As the water gets hotter it mounts in the glass tube and causes a pressure on the caoutchouc membrane of the regulator, and this lowers the flame by diminishing the current of gas supplied. If the temperature lowers the water descends and the gas is supplied more freely. Should the apparatus have been regulated for too high a temperature some water is introduced into the tube by means of a fine pipette, and *per contra* some is withdrawn by removing the caoutchouc plug if the temperature has been regulated too low. It is stated that the regularity of this hot stage is such that even under unfavourable conditions it does not vary more than a few tenths of a degree.

Julien's Immersion Heating Apparatus.*—Dr. A. A. Julien's "immersion apparatus" was devised for the special purpose of exactly determining the temperature of expansion of the liquid in the fluid cavities of minerals. He considers that most of the forms hitherto devised are "extremely inaccurate, often complex and untrustworthy, and it may be owing to this cause that Brewster obtained, for the critical temperature of the liquids in quartz, results of the very wide range between 20° and 51° C."

The author in a previous paper thus expressed himself on the subject. "The objection to all these forms of apparatus lies in their irregular application of heat, and its irregular and indefinite loss from currents in the surrounding atmosphere, and from the refrigerating effect of the mass of metal in the stage, and also in the objective, in an amount proportionate to its close approximation, i.e. to its focal distance or high power. Even in the most pretentious apparatus, that of Vogelsang, its inventor admits a variation or error of 10° C., according to the objective employed; from a No. 4 Hartnack of 3 mm. focal distance to a No. 9 of 0·1 mm. Vogelsang suggested the reduction of observations made by means of high-power objectives to the standard of the No. 4, and was even forced to make a plus correction of 1° C. for observations in which the temperature of the air of the room and of the Microscope fell below his normal (20° C.) as far as 12° to 15°. Practically, in use these observations are consequently made almost altogether on large cavities and under low-power objectives, and an accuracy to 1° C. has been accepted as satisfactory. Although wide discrepancies have constantly occurred, even in determinations on the fluid cavities in the same slice of mineral by means of these devices, on the other hand some of the most delicate and important investigations, such as those of Sorby and King on the indication of the degrees of pressure to which certain granites have been subjected during folding and metamorphism, have rested largely upon the accuracy of determinations of this very kind." †

Brewster, Sorby, and Hartley have used the same principle as the author, Hartley adopting the plan of immersing the slide in water of known temperature, removing, wiping it hastily, placing it on the stage, and instantly examining it.‡ Far more accurate results with greater convenience can, however, be obtained by means of an apparatus permitting the slide to remain under observation, immersed in a layer of water on the stage, and continuously warmed by a current of air from the breath of the observer, or, if necessary, by the conduction of heat to the bottom of the

* Journ. N. York Micr. Soc., i. (1885) pp. 137-9. See also this Journal, 1882, p. 266.
† Amer. Mon. Micr. Journ. v. (1884) pp. 189-90.
‡ Journ. Chem. Soc. London, 1876, p. 139.

vessel from a small flame at the side of the stage. By this means an accurate determination of the actual temperature at which a fluid inclusion expands into a gaseous state may be obtained in a few minutes to 0·05 C°.

The simplest form of the apparatus consists of three parts, as follows:—

1. A shallow glass tank, such as may be cut off the bottom of a chemical beaker, of sufficient diameter for the slide to lie within it, just immersed in a thin layer of water, but separated from the bottom by two little blocks of rubber or glass. This tank is placed upon the stage.

2. A chemical thermometer of sufficient delicacy, with a short bulb, or with a long bulb bent at a right angle. This is inserted in the tank, as nearly upright as possible, and the depth of the water is made just enough to cover the bulb. The length of the scale should be such as to bring the degrees between 27° and 32° near the level of the observer's eye when it is at the eye-piece, to facilitate immediate observation without the delay caused by moving the head.

3. A piece of small rubber tubing tied to the body of the stand, with the upper end inserted in the observer's mouth, and with the lower end, which terminates in a short piece of glass tubing drawn to a fine aperture, lying in the water on the bottom of the tank.

An immersion objective may be employed or, if the cavity be large, any objective of lower power may be used, with its front immersed in the water. After the cavity has been brought into sharp focus, a steady but gentle stream of air is blown through the tube, the immersion of the objective preventing interference from the waves on the surface of the agitated water. The cavity is continuously observed, as the bath and the immersed thin section are gradually warmed by the current of the observer's breath, and when the critical point is reached and the liquid contents of the cavity suddenly disappear, a quick observation of the thermometer is made.

Again, as the bath cools—which process may in hot weather be hastened by adding carefully a few drops of cool water, with continual agitation by the air current—the original bubble may be observed to leap back into view, and a second observation of the thermometer is taken as a check to the first.

If a higher temperature be required for other uses of this apparatus, oil or other liquid may be substituted for the water in the bath, and it may be heated by conduction from a taper or lamp burning by the side of the stage, through a stiff slip of copper introduced beneath the glass tank. A small hole, for observation, through this copper slip should be placed immediately over the centre of the aperture of the stage. The apparatus may be further protected from radiation of heat, and more uniform results ensured, by inclosing the tank in a ring of pasteboard or sheet cork, and by inserting plates of cork between the copper plate and the stage.

Unequal Heating of Crystal Sections.*—Dr. W. Klein, for studying the alterations of optical characters in crystals, produced by unequal heating, suggests the use of a plate of copper, resting upon one side of the crystal, the other end of the plate being heated in a spirit-lamp. To accelerate the process, and to obtain the means of rotating the section during heating, it is better to use a pair of copper forceps attached to a wooden ring, so that the points of the forceps in which the section is held come exactly into the centre of the ring; between the ring and the forceps is a layer of asbestos. The whole is laid upon the stage, and the projecting end of the forceps heated by a spirit-lamp. By this method the crystal is heated on one side on both the upper and lower surfaces.

* Zeitschr. f. Krystallogr. u. Mineral., ix. (1884) pp. 38–72.

Culture Glass for examining Micro-organisms.*—The glass invented by Dr. F. Lipeż consists of a flat and a round part. The former is for the reception of the nutrient medium; the latter for the cotton-wool plug.

FIG. 108.

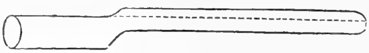


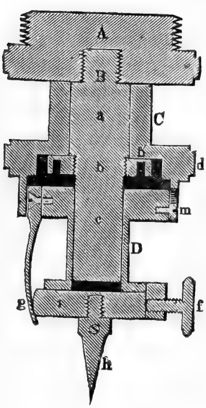
FIG. 109.

Fig. 108 shows the instrument in section; fig. 109 from the surface. One-third the natural size.

The nutrient medium is only spread in a thin layer on the lower surface of the glass. The advantages claimed for this glass over the ordinary plate method are: (1) The simplicity of its application, for it is a storehouse as well as a laboratory; (2) its certainty of preventing ingress of extraneous organisms, &c; (3) it allows the colonies to be examined with low powers, and to be extracted for examination if need be; (4) it allows the action of certain gases in the organisms to be observed with facility—e.g. CO^2 can be poured in and H gas poured up, according to the position of the aperture.

Schiefferdecker's Apparatus for Marking Microscopical Objects.†—Dr. P. Schiefferdecker's apparatus (fig. 110) is essentially a diamond point for scratching circles on the cover-glass, so that any particular spot can be easily found.

FIG. 110.



It consists of the screw-head A, to which is united the piece B, of unequal length and diameter at *a* and *c*. At *b* are a few threads for working in the female screw *b'*, which supports the revolving cylinder C, but without interfering with its movements. C is united to a second revolving cylinder D by means of the screw *m*. A linear aperture at *m* allows free up and down movement of the parts from D to *h*. The horizontal slide *i* is moved by the screw *f* and the spring *g*. At the end of *h* is a diamond point. The apparatus is screwed to the body-tube in place of the objective, and *h* is moved out excentrically to the desired extent, and a circle is scratched on the cover-glass by turning the raised rim *d* round through 360°. By this means circles of 0·25 to 0·20 mm. diameter can be described. Of course it is necessary that the cover-glass should be firmly fixed.

Microscopic Measurement of Indices of Refraction and Axial Angle of Minerals.—M. E. Bertrand ‡ is able to observe the optic axes in a mineral of which the true axial angle is 145°, by increasing the aperture of the condenser and objective, and using a strongly refracting immersion liquid. For this purpose, the condenser consists of three lenses, which are respectively hemispherical of 5 mm. radius, 5 mm. thick with 12 mm. radius, and 19 mm. diameter with 60 mm. focal length; the objective consists of 3 lenses which are respectively hemispherical of $1\frac{1}{2}$ mm. radius,

* Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 401–2 (2 figs.).
† Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 461–4 (1 fig.).
‡ Bull. Soc. Min. de France, viii. (1885) pp. 29–31, 377–83.

3 mm. thick with 5 mm. radius, 2 mm. thick with 12 mm. radius. The polarizer need not have a field of more than 20°. For sections of from 0·1–0·01 mm. thickness a fourth lens of 13 mm. diameter and 4·5 mm. focal length is added to the objective, and to obviate the difficulty of mounting very small fragments of crystals for the measurement of the axial angle, this fourth lens, together with the eye-piece and analyser, is made to turn about an axis perpendicular to the axis of the Microscope, and passing through the section, the angle of rotation being measurable.

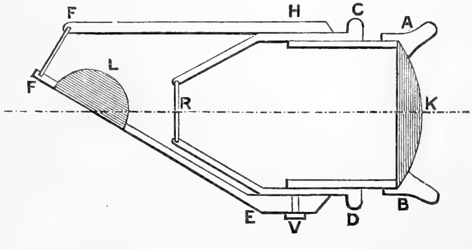
In making the measurement the whole body-tube is depressed until the objective is in contact with the section in the immersion liquid; adjustment to a satisfactory part of the section is then made by the eye-piece tube, and the upper part of the tube is raised until the interference curves are seen; the angle is then measured by rotation about the axis mentioned above. Since a certain rotation of the upper part of the tube corresponds to the angle of total reflection, this disposition of the instrument renders it possible to measure the index of refraction at the same time.

On the same principle M. Bertrand has constructed a new refractometer for rock sections.* The rotation of the upper part of the tube is here replaced by a rotation of the hemispherical lens, which is now fixed to the axis of a small goniometer, carried by a separate pillar mounted on the Microscope-stand. The objective of the Microscope consists of an achromatic lens of 30 mm. focal length, and above it is a diaphragm with a slit 1/4–1/2 mm. in breadth, and 3 mm. in length, parallel to the axis of the goniometer.

The section together with the polarizer is kept in contact with the hemispherical lens by a spring. When the limit of total reflection is reached by a rotation of the goniometer axis, the upper part of the section is bright and the lower part dark, so that the boundary line may be adjusted to the cross wire. The section is illuminated from above by means of a hole in a screen which allows the light to fall only upon the mineral under examination. When the instrument is carefully adjusted, this method will give the refractive index correct to 2 or 3 units in the third decimal place.

Bertrand's Refractometer.†—This instrument, designed by M. E. Bertrand, may be used for solids or liquids, and gives the index correct to two places of decimals by a single reading.

Fig. 111.



A B, fig. 111, is the eye-piece carrying a lens of crown glass of 4 cm. focus; it slides in the tube C D which is conical at the further end, and is provided with a reticule R consisting of a glass disc 8 mm. in diameter engraved with 80 divisions, 1/10 mm. apart and numbered by tens. C D slides in the tube E F F H, the lower face of which is an elliptical section, making an angle of 30° with the axis, and carrying the hemispherical flint-glass lens L of 5 mm. radius fixed in a copper disc. The plane surface of this lens faces outwards, and its centre is in the axis

* Bull. Soc. Min. de France, viii. (1885) pp. 426–8, and ix. (1886) pp. 15–21.

† Op. cit., viii. (1885) pp. 375–7. Cf. Le Génie Civil, and Eng. Mech., xliii. (1886) p. 453 (1 fig.).

of the instrument. F F is a small aperture filled with ground glass which admits light, and V is a screw to fix the tube C D when it is so adjusted that R is at the focus of the lens.

To find the index of a liquid, a drop is placed upon the plane surface of L; of the rays refracted through L, those which have an angle of incidence greater than the critical angle are totally reflected at the surface of the liquid, and illuminate the lower portion of the reticule; the upper part remains dark, and the position of the boundary line depends upon the critical angle, and, therefore, upon the index; if then the value of the graduations is known, the index is read directly from the position of this line upon the scale.

For solids, a polished plane surface is placed against the lens, a liquid of higher index having been interposed between them, two boundary lines are then seen, one of which belongs to the liquid, and the other to the solid; the latter gives the required index directly.

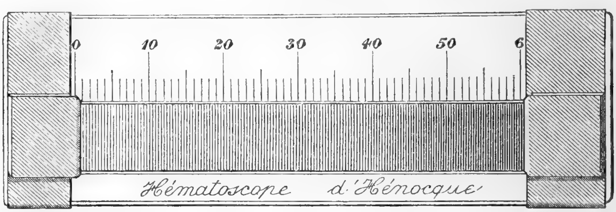
M. Bertrand uses as an immersion liquid, with substances of high refractive index, dibromated naphthyl-phenylacetone, to which a few drops of bromated naphthalene have been added.

The instrument is graduated by determining the position of the boundary line for different solids and liquids of known refractive index.

Hæmatoscopy.* — M. Hénocque under this name indicates a new spectroscopic method of analysing the blood. This method comprises two modes of observation: 1st, the determination of the quantity of oxyhæmoglobin by instruments called *hæmatoscopes* and *hæmatospectroscopes*; 2nd, an estimation of the time of reduction of the oxyhæmoglobin by spectroscopic examination through the thumb-nail. The ratio of these serves to measure the activity of the reduction.

In the estimation of the quantity of active colouring matter by the hæmatoscope an apparatus is used (fig. 112) which consists of two super-

FIG. 112.



posed plates of glass which are in contact at one end and are separated by an interval of 0·03 mm. at the other; a few drops of undiluted blood inserted between the plates form a layer of gradually increasing thickness and intensity of colour, and the thickness is measured by a millimetric scale engraved on the glass. The amount of colouring matter is estimated by observing the point of the scale at which the two characteristic bands of oxyhæmoglobin appear equally dark in a direct vision spectroscope. For example, blood containing 14 per cent. of oxyhæmoglobin examined by daylight will give two bands of equal darkness with a thickness of 0·07 mm., the bands are also of equal breadth and occupy the spaces 530 to 550 and 570 to 590 in the spectrum measured in wave-lengths; the percentages of oxyhæmoglobin corresponding to different points of the scale are given by a comparative table.

* Comptes Rendus, ciii. (1886) pp. 817–20 (3 figs.).

On looking through the thumb-nail with a direct-vision spectroscope the first characteristic band is seen, sometimes accompanied by the second. When a ligature is made round the joint the bands disappear, the yellow at the border of the ray D then slowly reappears, and finally the bands disappear entirely; the time occupied is the *time of reduction*, and varies between 25 and 90 seconds, the normal time being about 60 seconds in health and in a state of rest; it is connected with the quantity of oxyhæmoglobin and the rapidity of exchange between the blood and the tissues.

Fig. 113 represents a hæmatospectroscope with the lateral movements which are required to study the phenomenon of the two bands; it is provided with a micrometric scale divided in wave-lengths. Fig. 114 is a

Fig. 113.

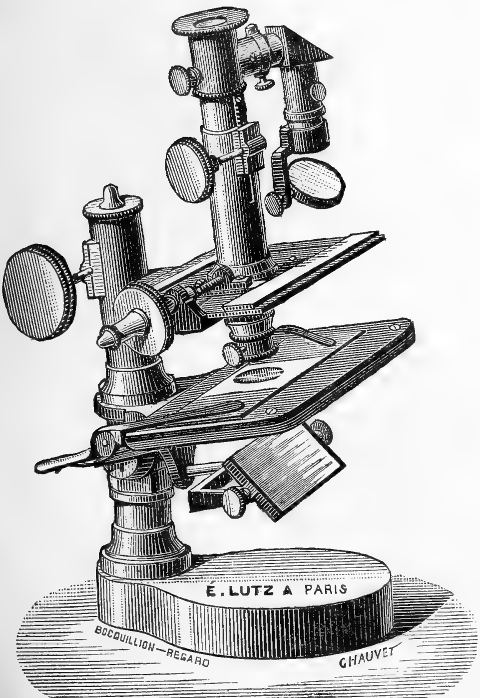
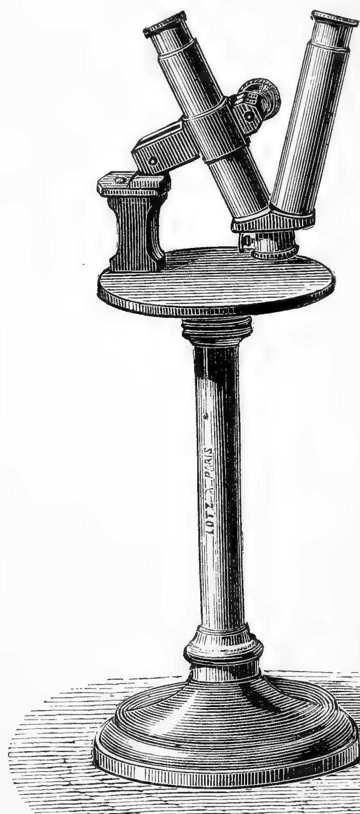


Fig. 114.

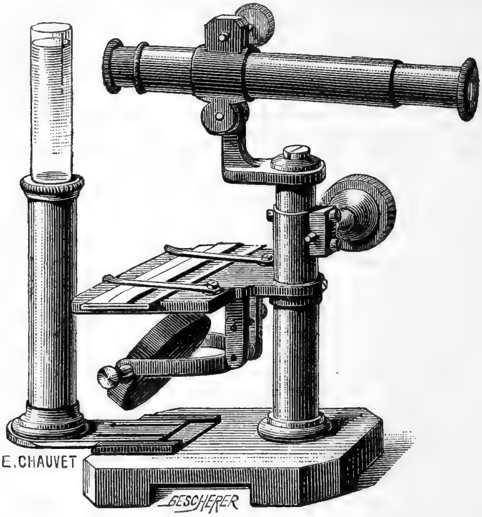


double hæmatospectroscope with a single slit by which two persons can observe the same phenomena simultaneously. The form shown in fig. 115 allows the spectroscope to be placed horizontally.

Experiment having shown that in the normal condition when the blood contains 14 per cent. of oxyhæmoglobin the mean time of reduction is

66 seconds, it may be assumed that the quantity reduced in one second is 0·20 per cent. If this quantity be taken as the unit of activity of reduc-

Fig. 115.

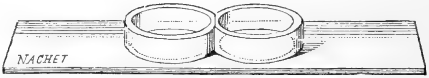


tion, then the following formula gives the activity corresponding to any values of the time of reduction and quantity of oxyhæmoglobin determined by the above methods.

$$\text{Activity of reduction } \epsilon = \frac{\text{quantity of oxyhæmoglobin}}{\text{time of reduction}} \times 5.$$

Hayem's Chromometer.—Prof. G. Hayem's apparatus for measuring the quantity of hæmoglobin in the blood consists of two cells arranged on

Fig. 116.



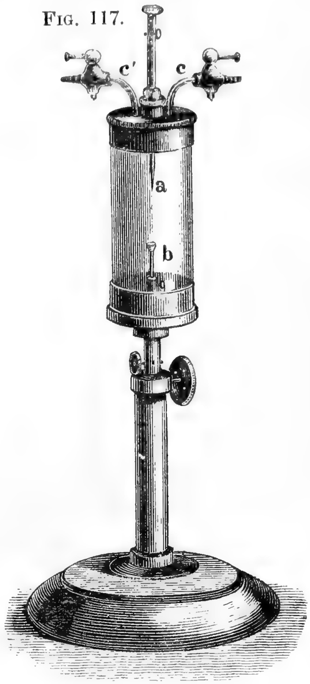
a slide as in fig. 116, one of which is filled with dilute blood and the other with pure water, the slide being placed on a standard colour for comparison.

Spectrum Analysis in Micro-Mineralogy.*—Dr. K. de Kroustchoff believes that he has found a method which, by the aid of spectrum analysis, will allow quantities that are unrecognizable by ordinary means to be easily identified. For this purpose he uses an apparatus which consists of a glass cylinder closed at both ends by a brass cap. In the upper cap is a stuffing-box, through which a brass rod, with a platinum point for an electrode *a*, plays up and down. Through the upper cap also pass two brass tubes,

* Bull. Soc. Minéral. France, vii. (1884) pp. 243–9 (1 pl.).

fitted with taps c and c'. The lower cap is also provided with a brass rod, upon which, by means of a screw, can be fastened bits of metal or carbon, b. This is the second electrode. The small cones of birch-wood charcoal are freed as far as possible from foreign bodies by prolonged treatment with acids and alkalis, followed by prolonged boiling. The carbons can now be used in various ways. If liquid, the carbons are soaked therein. Other matter is first heated in a platinum vessel with dry chlorine gas. The gas with chlorides is then passed through a tube containing some carbons, which become impregnated by the substances. Combinations other than chlorides are deposited on the walls of the tube; these are placed in a hole in the carbon, or in small platinum or aluminium cups soldered to b.

FIG. 117.



When the substance to be examined is arranged in the apparatus, the latter is filled with dry hydrogen, and the electrodes united with the poles of a battery. When the current is closed the spectrum is observed.

By this method a thin microlith, 0·02 mm. by 0·001 mm., observed in a piece of Podolsk quartz, was found to consist of aluminium, beryl, and silicon; consequently the microlith was beryl.

COPPER.—**Achromatic Condensers.** *Engl. Mech.*, XLV. (1887) p. 300.

GILL, R.—**Camera Lucida.**
[Describes one made of a cover-glass, and costing the fraction of a penny.]
Sci.-Gossip, 1887, p. 116.

LEACH, W.—**The Lantern Microscope.**
[Describes his arrangements for illumination.]
Engl. Mech., XLV. (1887) pp. 50–1.

TERRY, W. A.—**Notes on Diatom Study.**
[Varnish cell 1/100 in. thick for studying motions of diatoms.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 44–6.

TRŒSTER, C.—**Hilfsvorrichtung für das Mikroskopiren bei Lampenlicht.** (Contrivance for use with the Microscope by lamplight.)
[Plate of blue-tinted glass, one side of which is dull, placed in the aperture of the stage so that the mirror and condenser form an image of the lamp-flame upon the dull surface. This will be found to obviate the two chief objections to the use of lamplight, namely, the colour, and the parallelism of the rays which gives rise to interference phenomena.]
Zeitschr. f. Instrumentenk., VII. (1887) p. 65.

(4) Photomicrography.

Photographic Apparatus for the Microscope.—The introduction of dry plates has given such an impetus to photomicrography, that in the course of last year we commenced to collect the illustrations for an extended notice of the various forms of photomicrographic apparatus. On reviewing them, however, we fear that many have now scarcely more than an historical

interest, and we have therefore made a limited selection (hardly more than a quarter!) which may serve to give a few hints to any who desire to contrive any variations on the forms hitherto in use.

I. Of those which have now a purely historical interest only, are Prof. *J. Gerlach's* * (fig. 118) and *Möller and Emmerich's* † (fig. 119). These require no description.

Fig. 118.

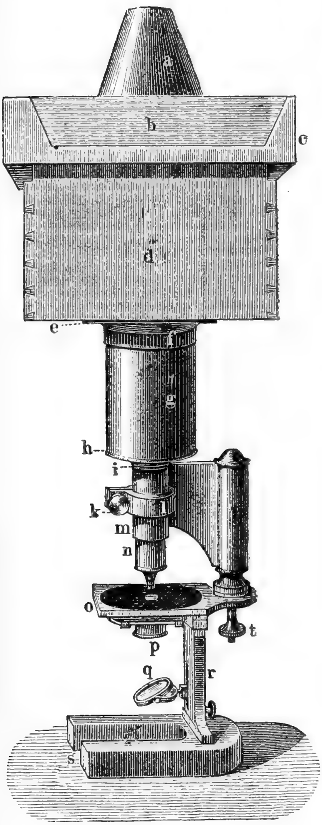
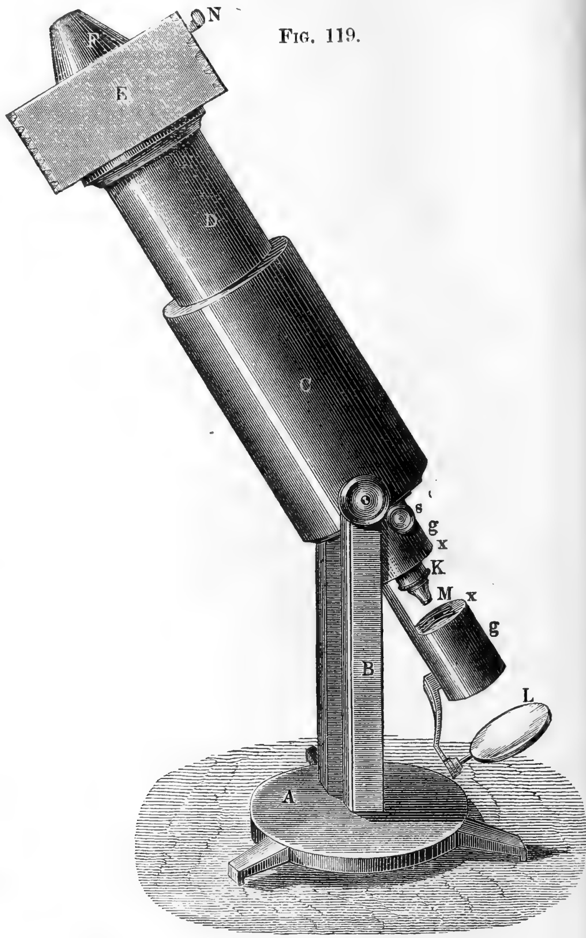


Fig. 119.



Nearly the same remarks apply to the complicated arrangements of *Dr. B. Benecke* ‡ (figs. 120 and 121) intended for use with the highest powers.

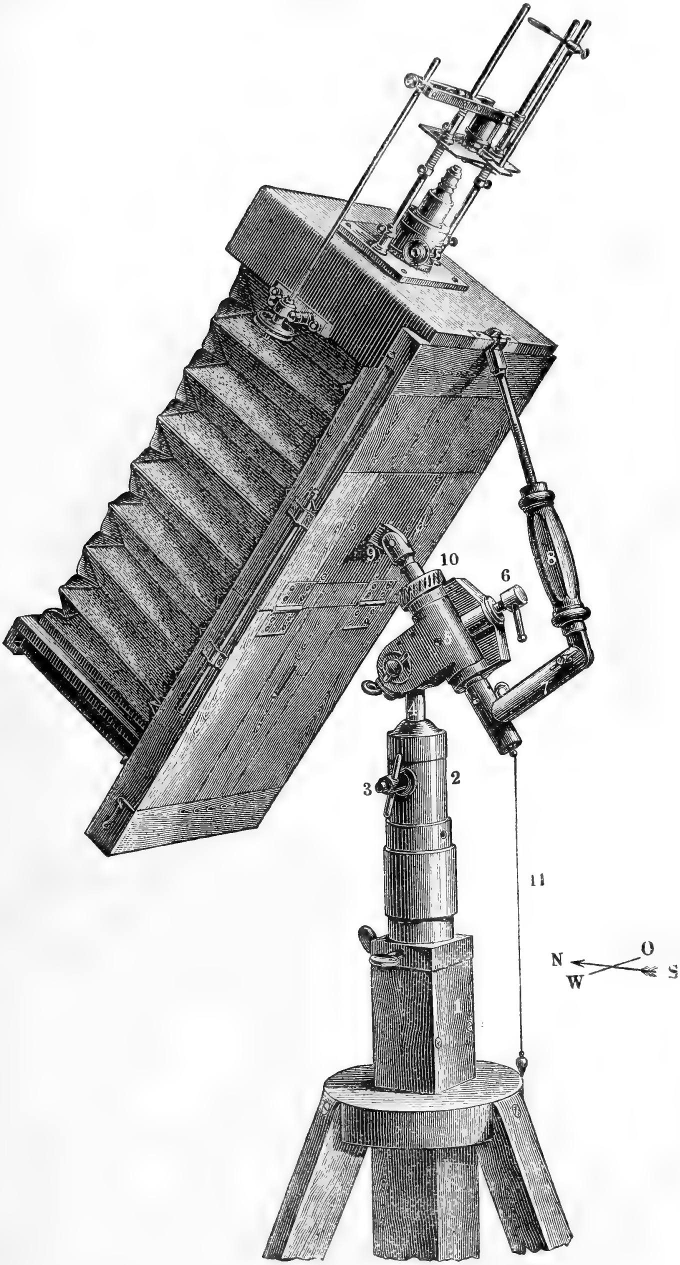
Fig. 120 shows the camera as mounted on a stand for use with direct sunlight and without any mirror. The stand is so contrived that when once

* 'Die Photographie als Hülfsmittel mikroskopischer Forschung,' 1863, viii. and 86 pp., 9 figs. and 4 pls. of photomicrographs.

† Cf. Dippel's 'Das Mikroskop,' 1867, p. 211–3 (2 figs.).

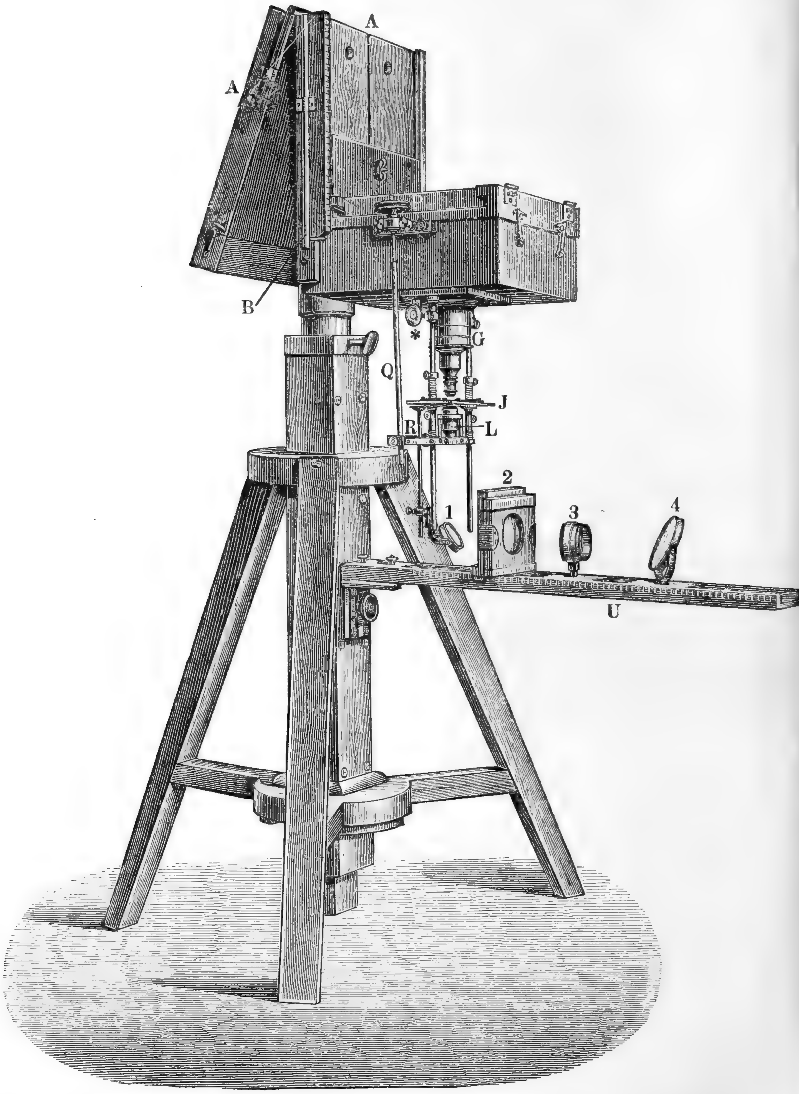
‡ 'Die Photographie als Hilfsmittel mikroskopischer Forschung (nach dem Französisch von Dr. A. Moitessier),' 1868, xiv. and 265 pp., 88 figs. and 2 pls. of photomicrographs.

FIG. 120.



set the sun can be followed by turning a single screw. Where the objects require to lie horizontally the apparatus is arranged as in fig. 121. The camera can of course be used without the stand.*

Fig. 121.



* It may be noted here that the "Jumbo" Microscope described in this Journal, 1882, p. 805 was intended for photomicrography. Mr. G. Lowdon, of Dundee, recently wrote us as follows:—"This large Microscope was made by me to order in 1850 and sent to the South of Ireland. The achromatic that then went with it, as well as the eye-lens, were likewise made here. The mechanical motion then cost me a considerable amount of trouble, as I had not seen in Scotland any Microscope above the value of 10*l.*, and those generally made by Sutton, and common enough.

This instrument was made to photograph on paper any object the party wished.

II. *Cameras for Vertical Microscopes.*—A variety of forms of camera have been devised for use with vertical Microscopes. The simple form suggested by *Moitessier* * is shown in figs. 122, 123, and 124 (the box taking two plates) and *Stein's* † in fig. 125, as fitted for the electric light.

FIGS. 122 and 123.

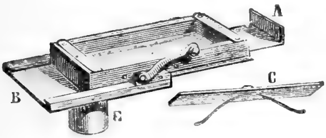


FIG. 124.

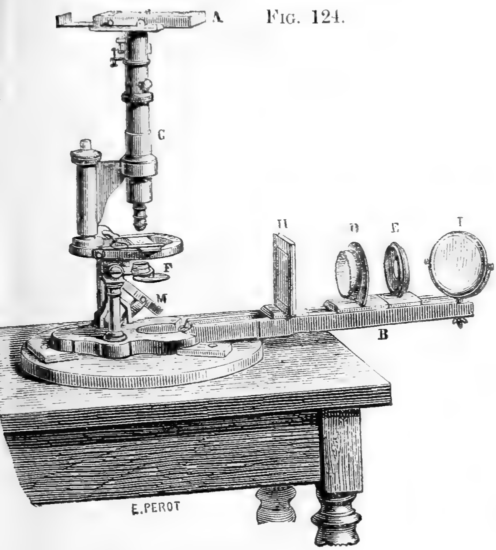
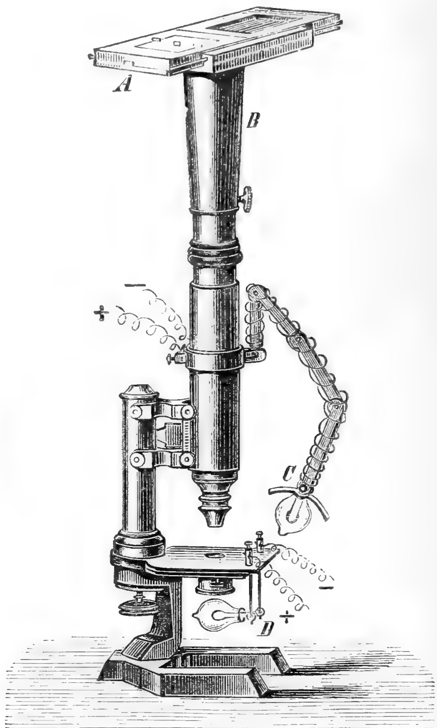


FIG. 125.



Reichert's (fig. 126) is a convenient arrangement — more so than *Meyer's* ‡ (fig. 127). Both agree in having the camera supported on a separate stand by the side of the Microscope.

There was, and likely is still, an opening in the eye-piece beside the diaphragm, through which a dark slide made of brass, platinized, was put. It was focused by allowing the sun's rays to fall direct on the mirror and hence direct through the object and objective up the tube on an obscured glass, having the same plane as the slide. The paper used by me was the waxed sort as then prepared by Le Gray. The exposure in the instrument was as a rule one hour, supposing the object was a fly's tongue. The size of the tongue with an inch objective generally covered the size of slide opening 2 in., and made a passable image, only in those days photography was very crude and collodion had not then appeared. It left me in July 1851, and I find I charged for it altogether 32*l*. I have made many a Microscope since then, but all of the standard sizes. I do not know if the party who got it ever photographed with it, but I fear he did not, as the process then was not simple enough.'

* A. Moitessier, 'La Photographie appliquée aux Recherches Micrographiques,' 1886, 334 pp., 41 figs., and 3 pls. of photomicrographs.

† S. T. Stein, 'Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung,' 1884, pp. 173 and 217 (2 figs.). Cf. this Journal, 1885, p. 303.

‡ S. T. Stein, op. cit., p. 172.

Fig. 126.

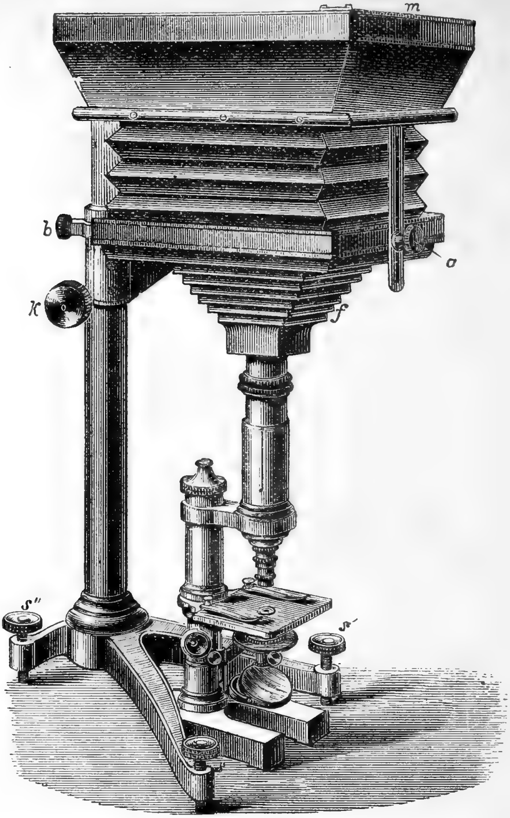
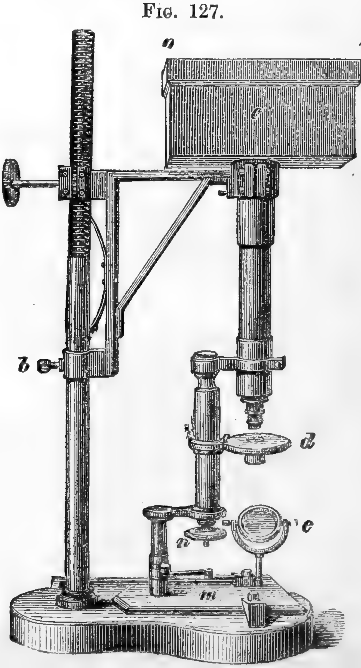


Fig. 127.



Prof. A. Girard's Photomicrographic Camera as made by M. Nachet (fig. 128) allows of the observer remaining seated and conducting all the

Fig. 128.

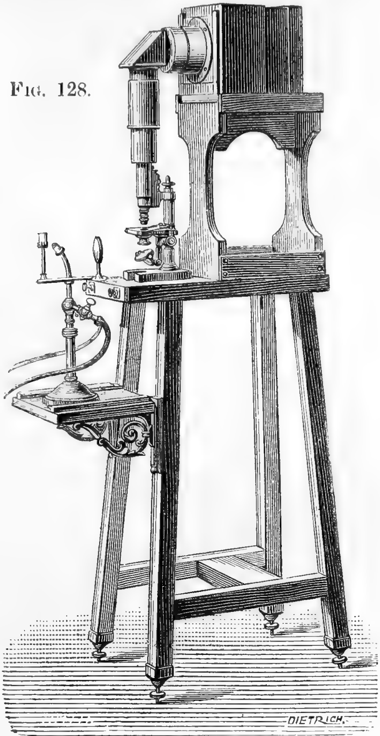
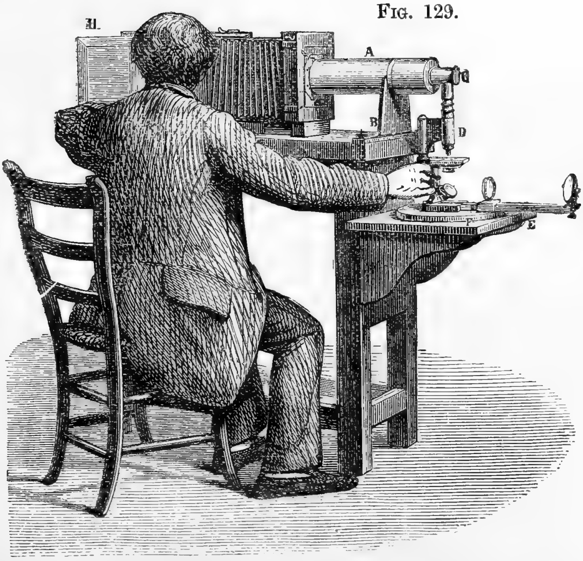


Fig. 129.



necessary manipulations at the length of the arm, and with a vertical Microscope. Focusing, adjustment of illumination, &c., can be done with the hand without moving from the seat, and without having to leave the image. This is accomplished by placing at the end of the tube of the camera a plane silvered mirror at an angle of 45°, which receives the rays from the Microscope and deflects them into the camera. Any Microscope can be used. The stand has a bracket for an oxyhydrogen or electric lamp.

Dr. A. Moitessier earlier described * a somewhat similar arrangement which took the form shown in fig. 129. It has the side door for focusing described in this Journal, 1886, p. 841.

Fig. 130.

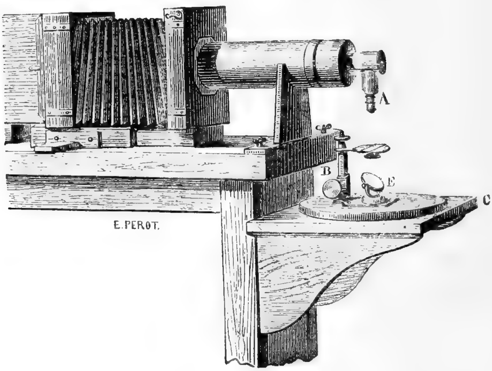
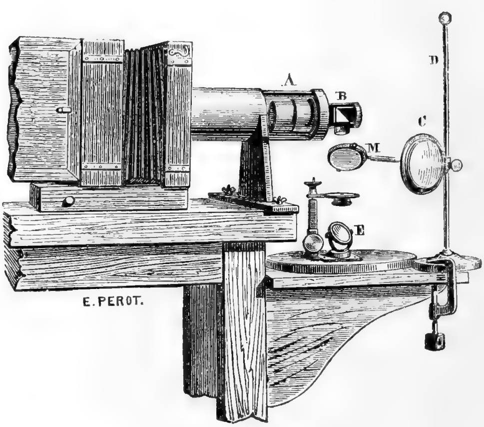


Fig. 131.



The latter form is also readily adapted for cases where small (fig. 130), or very small (fig. 131), enlargements (3–5) are required.† In the latter

* Op. cit., p. 131.

† Ibid., pp. 136 and 138.

case a photographic objective is placed behind the prisms. The adjustment for focus is made by moving the stage. These forms are specially suitable for opaque objects.

In *Nachet's* photomicrographic camera (figs. 132 and 133), M. A. Nachet has provided for its use either in a vertical, inclined, or horizontal position. This is accomplished by attaching it to two upright supports which can be

Fig. 132.

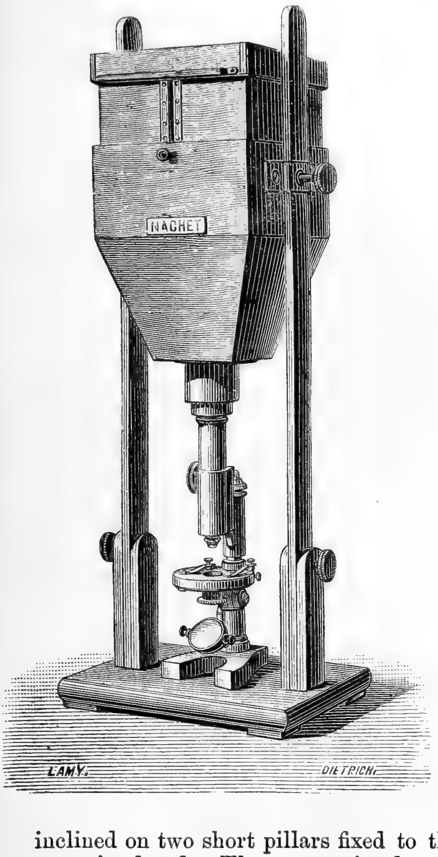
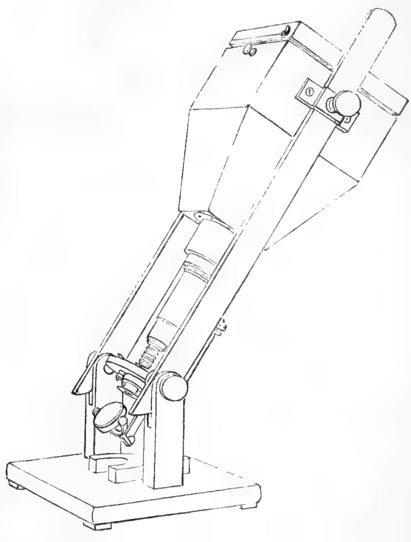


Fig. 133.



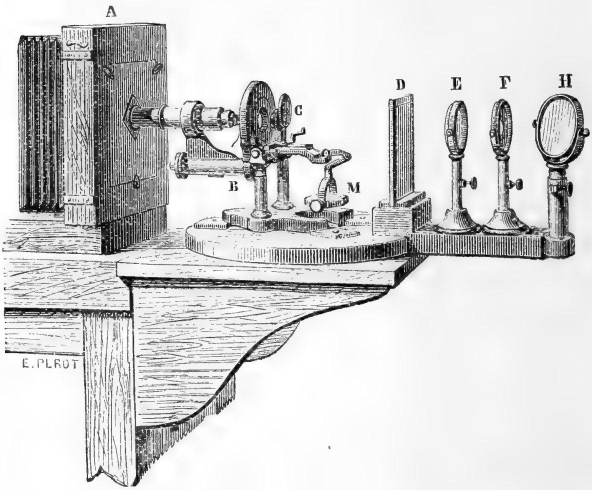
inclined on two short pillars fixed to the wooden base on which the Microscope is placed. The camera is also arranged to slide on the supports so that it can be raised or lowered, and set at different heights. Adapter-tubes of special construction are applied to the body-tube to connect it with the camera, which are so arranged that the focal adjustments of the Microscope are made independent of the adjustment of the camera, and at the same time no extraneous light is allowed to enter at the connection.

III. *Cameras for Horizontal Microscopes.*—Of these there are an endless number :—*Moitessier's* * (fig. 134) makes use of an ordinary Microscope.

* Op. cit., p. 134.

In *Reichert's* apparatus (fig. 135) the camera C slides on a base-board between guides *a* and *b*, a graduated scale and index *z* recording the position. It can be levelled by screws *s* at one end. The lengthening-piece Z is removable when the camera is required to be brought nearer to the Micro-

FIG. 134.



scope. The ground glass is moved by rack and pinion T, or for fine-adjustment by *m*.

The Microscope D is connected with the camera by a light-proof connection at K, and is fastened to the base by a screw at F. The fine-adjustment screw head E is toothed, and is turned by a larger toothed wheel *u* which is actuated by the prism *g* at the end of the rod *Sp*. The other end of the rod reaches to *k* where it is turned by the milled head *h*.

For illumination by transmitted light a mirror P and condensing lens L slide in the groove *l*. There is also a holder B for holding fluids, either for controlling the illumination or for stopping the heat rays. For opaque objects there is a second mirror H on a support *r*.

Seibert's (fig. 136) and *Vérick's* (fig. 137) have each special arrangements for focusing. In the original form of the former the screw head had teeth cut in it in which a toothed wheel worked, the wheel being actuated by a double-jointed rod. This is now modified, as shown in the fig., a system of pulleys and cords being used. In the latter there is a rod and one pulley, the head of the fine-adjustment screw being also grooved to receive the cord.

For photomicrography *Dr. Zeiss* modifies his No. 1 stand as shown in fig. 138. The chief differences are that the body is shorter and of greater diameter, so as to interfere as little as possible with the cone of rays transmitted by the objective, and that there is an extra large (140 × 120 mm.) mechanical stage with circular and rectangular motions. The draw-tube is also tapped at its lower end with the ordinary objective thread, to receive when required a photographic correcting lens, to correct the objective for a picture 1 to $1\frac{1}{2}$ metres distant. The stage and body-tube are fixed and do not revolve round the optic axis.

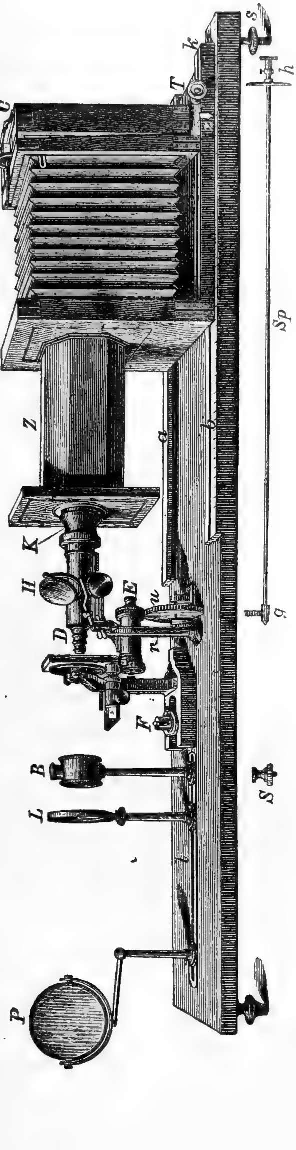


FIG. 135.

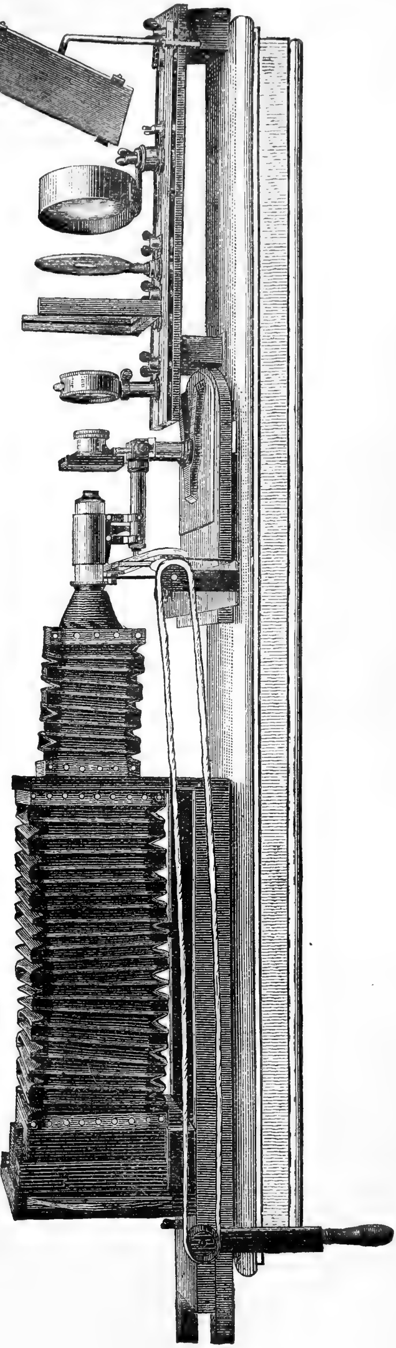


FIG. 136.

The larger form of camera is shown in fig. 138. It consists of an ordinary mahogany photographic camera of medium size, with extending arrangement, lengthening to about one metre, the amount of extension being registered on a scale on the lower part of the camera. There are two

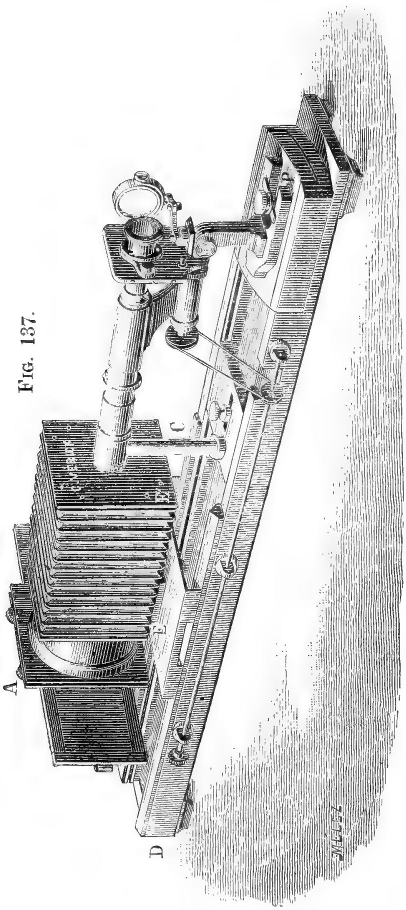


Fig. 137.

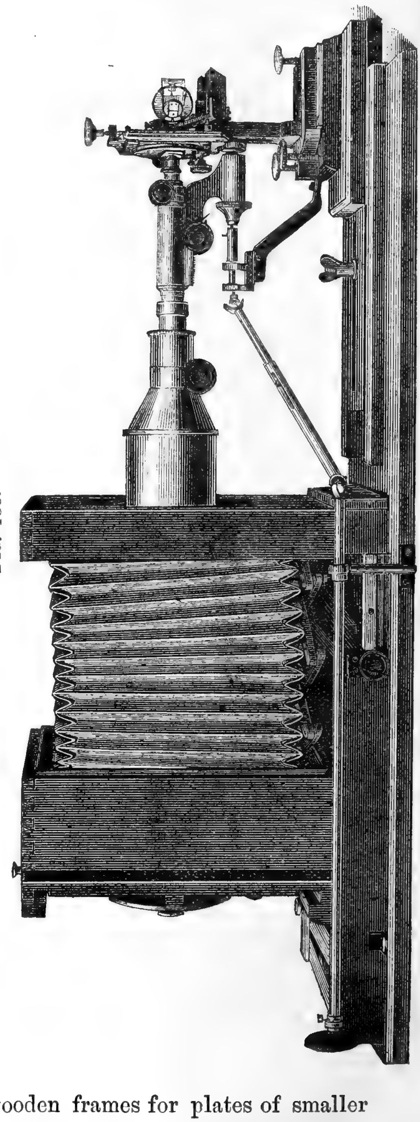


Fig. 138.

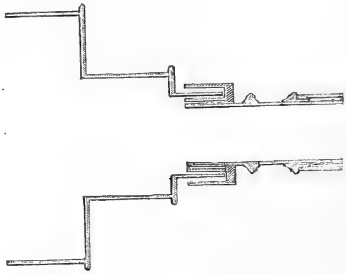
slides for plates, 23 cm. square, with wooden frames for plates of smaller dimensions.

The camera is fastened to a strong wooden base which also carries the Microscope, the fine-adjustment being worked by a long Hooke's joint. The Microscope does not stand directly on the wooden base, but on a heavy

metal plate on a wooden support. The former allows the axis of the Microscope to be brought into line with that of the camera by moving it laterally by hand; it is also adjustable by three screws. The wooden support can be freely moved to and from the camera, between guides on the base.

The end of the camera which is turned to the Microscope has a long brass nozzle, blackened inside, which carries a brass jacket moved by rack and pinion. This jacket is inserted into a double cap fitting on the end of the body-tube as shown in fig. 139. A connection between the camera and the Microscope is thus made which is impervious to light.

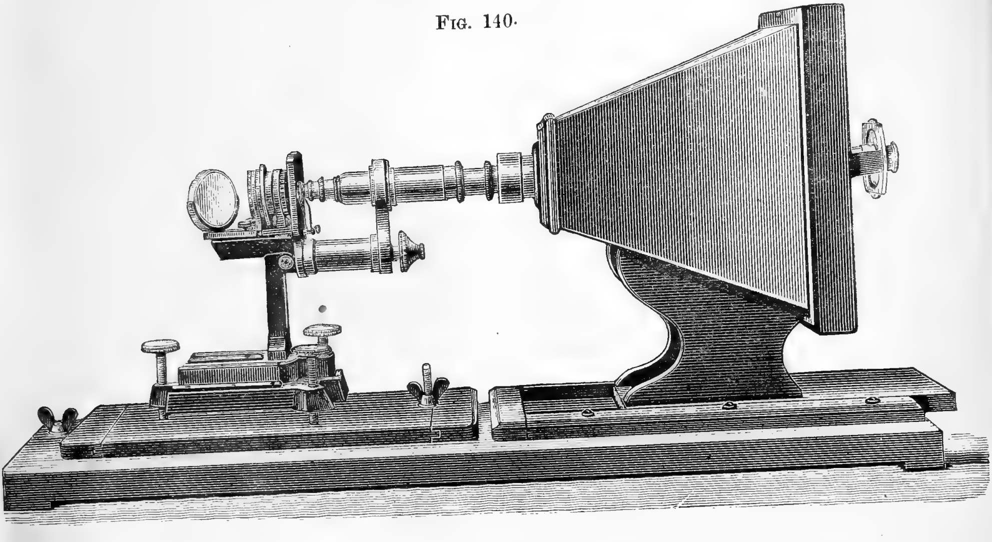
Fig. 139.



For fine-adjustment of the image after a rough focus on the ordinary ground glass, the latter is replaced by a frame with a disc of transparent plate glass having a cross cut with a diamond in its centre. A low power lens is focused on this mark and moved over the plate by a carrier, and the vaguely adjusted picture is then accurately focused.

In the smaller form of camera shown in fig. 140, there is a funnel-shaped non-extending camera which is intended for use with an eye-piece, as without it only small pictures can be obtained; the camera is movable between guides upon the wooden base. The plate-holders are 18 cm. square.

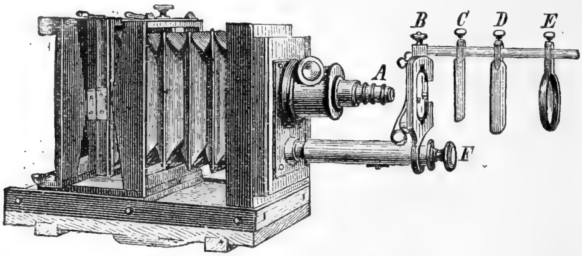
Fig. 140.



For a lamp is used the Siemens gas-burner on an adjustable brass stand and glass globe, described in this Journal, 1886, p. 515; the lamp is said to give an "excellent bright and white light which almost completely supplies the place of good daylight."

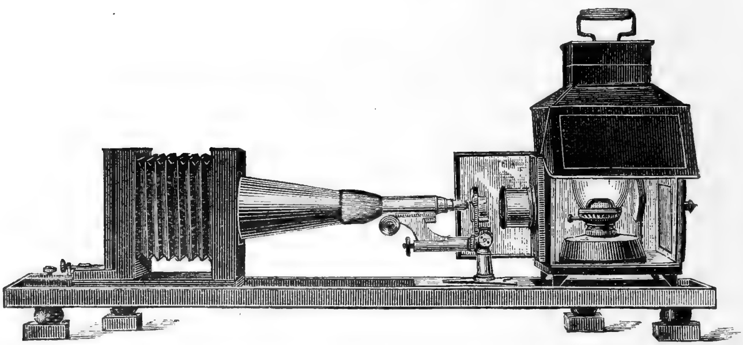
Klönne and Müller attach a standard in front of the camera carrying a stage B which is moved to and from the objective A by the fine-adjustment screw F. The stage has a rod for glass diaphragms C, D, and bull's-eye E.

Fig. 141.



Mr. J. Carbutt combines the camera and Microscope with a lantern in the manner shown in fig. 142.

Fig. 142.

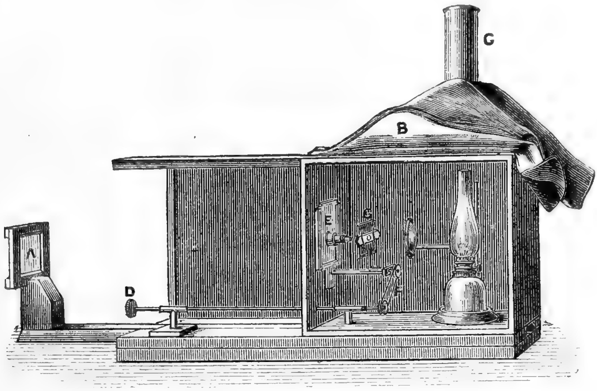


Mr. T. Charters White describes a "simple method of photographing biological subjects without using a Microscope."* The apparatus (fig. 143) consists of an oblong lidless box, laid on its side, and securely screwed to one end of a base-board 2 in. in thickness and $2\frac{1}{2}$ ft. in length. The upper central part of this base-board, about 1 in. in thickness, is made to slide in a dovetailed groove. The end of this sliding part carries the holders A for the plates employed, the holder being an ordinary photographic printing frame. The size of the holder is varied according to the amplification required, and by means of this sliding holder the magnification can be diminished or greatly extended as may be desired. The upper side of the box has an oblong opening cut in it over which a tin chimney C is fixed, thus allowing the lamp to approach or recede from the stage G as may be desirable. Another opening is made in that side of the box which faces the plate-holder, and central with it; this opening is closed by a movable brass plate E, having an adapter with the Society screw soldered into it. Below this plate a support carrying the movable stage is fixed to the side of the box, the stage being moved backwards and forwards by the focusing arrangement D, F. The light is derived from a lamp, burning the purest

* Sep. repr. from Journ. Brit. Dental Assoc., Oct. 1886, 8 pp. and 1 fig.

paraffin oil, in which is dissolved a lump of camphor of the size of a walnut to the ordinary reservoirful; this whitens the flame and renders it more actinic. A plano-convex lens, with the convex side towards the

Fig. 143.

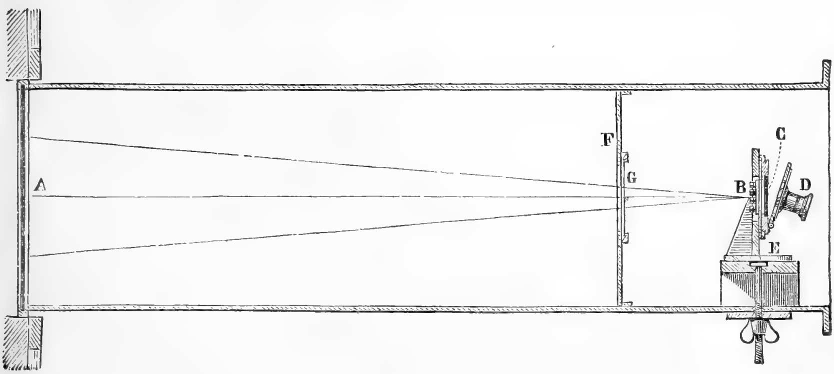


flame, concentrates the light on the object. A curtain of black velvet B falls over the front of the box, shutting all light in, and a shutter cuts off the rays coming through the objective till all is ready for them to fall on the sensitive plate.

Dagron's Microphotographic Apparatus.*—M. Dagron's apparatus for producing microscopic photographs (first used for pigeon despatches during the Franco-German war) is shown in figs. 144 and 145).

It consists of a long rectangular chamber closed at A by ground glass which is brightly illuminated from outside and on the inside of which is

Fig. 144.

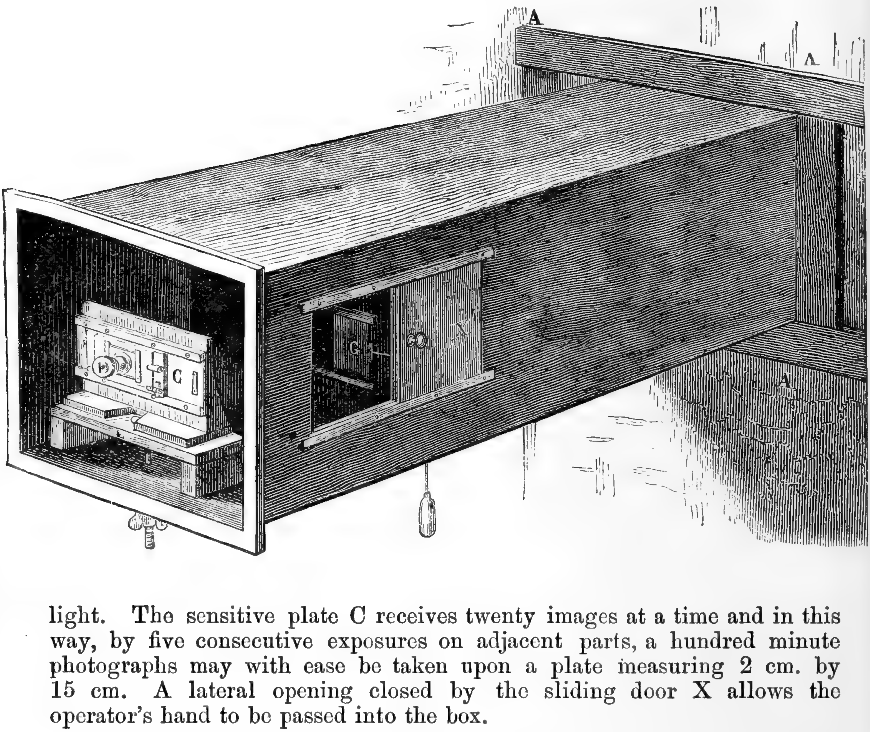


a clamp to hold the negative to be reduced. At the other end of the chamber is the photographic apparatus. At B is a set of 20 microscopic objectives arranged in rows of five, which project images upon a very finely

* S. T. Stein, 'Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung,' 1884, pp. 315–20 (3 figs.).

ground focusing screen provided with rectangular micrometric divisions; in each of which appears one of the twenty images. At D is hinged a small strongly magnifying Microscope by which the images may be focused, the whole being adjusted by a screw clamp at E. At about a quarter of the length of the chamber from B is a plate F with an opening closed by the sliding screen G held by a counterweight, so that when drawn aside it immediately returns, admitting an instantaneous flash of

Fig. 145.



light. The sensitive plate C receives twenty images at a time and in this way, by five consecutive exposures on adjacent parts, a hundred minute photographs may with ease be taken upon a plate measuring 2 cm. by 15 cm. A lateral opening closed by the sliding door X allows the operator's hand to be passed into the box.

Bousfield's 'Guide to the Science of Photo-micrography.'*—To those who for many years have watched the progress of photomicrography, and who must have often seen brought forward, as novelties and advantages, devices that were adopted years since, it will be very satisfactory to find in Dr. E. C. Bousfield's *brochure* not only a trustworthy guide to the gelatino-bromide process which has been selected, but a real advance in the endeavour to set the principles of the most difficult portion of the subject upon a scientific basis.

The rapid spread of photomicrography amongst microscopists is, doubtless, largely due to the facilities furnished by the use of the dry gelatino-bromide plates, and their sensitiveness to the rays from ordinary artificial

* Bousfield, E. C., 'A Guide to the Science of Photo-micrography; containing Exposure-tables and rules for working,' 69 pp. and Table, 8vo, London, 1887.

light, which enables the microscopist, without very much trouble, to secure at any moment a photomicrograph of the object he is examining, and with only a few minutes' delay; while formerly it was almost necessary to utilize sunlight either with or without an equatorially mounted prism, or some form of heliostat, or the solar Microscope; for the magnesium, oxyhydrogen, and electric lights, though so useful, never obtained more than a temporary claim. Looking to the quality of the results, possibly the palm would be granted to the wet collodion process, as gelatino-bromide negatives often show a fine granulation, absent in the collodion or albumen film, which interferes with enlargement. Still the advantages for general work lie with the dry bromide plate, which is the process the author adopts. All who have endeavoured to obtain the best results with the gelatino-bromide plates have from their great sensitiveness found a difficulty both in the time of exposure and the mode of illumination, and it is to both of these that the author devotes considerable attention, and introduces a more certain way to regulate the exposure according to the non-actinicity of the object, whether due to thickness or colour, to which may be added the difficulty occasioned by alteration in distance between the object and the screen, from a different manufacture of the plates, and from the use of different objectives of the same power. To meet these difficulties the author has constructed a scale or table by which to regulate the time of exposure under these different circumstances. This table of exposures has been ingeniously founded upon the visibility of the figures on Warnerke's sensitometer under the same illumination, and at the same distance of the screen as the gelatino-bromide plate will be placed at, as one of the terms, and used in conjunction with the known scale of the sensitiveness of the plates, either as stated by the maker, or as tested on trial with the same sensitometer, as the other term. These two terms or readings being known, the third, the time of exposure required in seconds for such a plate to be properly exposed, is indicated in the table up to ten minutes. Examples of the use of the scale are given, and every photomicrographer who wishes to work upon this, the most sure method of exposure yet devised, will heartily thank the author for his effort to supply a deficiency, which even long years of experience could not always obviate without the loss of a plate or two.

Dr. Bousfield rightly lays great stress upon the method of illumination when using a paraffin lamp, and points out the correct way of obtaining a brilliant field, or for securing a dark-ground illumination. It may here be noticed, in connection with this latter method of illumination, that stereoscopic photomicrography is passed over in silence, which we should have been glad to see noticed. Part of a chapter is devoted to the use of "orthochromatic" or "isochromatic" plates, with the use of tinted glass between the bull's-eye and condenser, to produce in the negative actinic contrast between the different parts of the object, *inter se*, and the background, and the author furnishes the following rule, "to use such a coloured screen as reduces the colour of the object to a neutral tint," a table being given of the different colours found most useful, and the number of seconds the time of exposure must be increased.

Many years since, Dr. Maddox, instead of using coloured glasses, employed coloured varnishes applied to the back of the slide, thus getting rid of one reflecting surface, and later he tried the use of a small globe filled with various coloured media and placed between the bull's-eye and substage condenser, but nearer the latter, thus obtaining a further concentration of the light.

The author seems to lean to the use of the eye-piece combined with the

objective, though it is still an open question whether better negatives cannot be produced without its use, for the dangers of absolutely correct centering are very great. He also appears rather to prefer the use of the old term microphotography, but he certainly acted wisely in adhering to what is now the standard and well recognised term which, however imperfect, has been admitted since 1864, if not earlier, although the fatherhood has been made somewhat doubtful by the impossibility of finding any printed record of its first use. It has, however, been so generally accepted by the foremost workers since that time, that no other nomenclature can now take its place. Macrophotography was proposed many years since, but never found favour, for it would rather apply to reasonable enlargements, whether from photomicrographs or ordinary negatives, than to the photographic image produced by the Microscope in the first instance.

The photographic use of the new "Apochromatic" objectives with their accompanying "projection" eye-pieces receives a favourable notice, and theory is certainly in their favour.

There are some points in this manual which are a little dogmatic, and others which may be enlarged upon in future editions with advantage to the beginner. The retention of the ordinary brass photographic mount, the lenses being removed, is very questionable unless the screw rims be perfectly blackened, and then if there be a central diaphragm the field may be too much limited. The attempt to photograph different planes by successive focusing, however perfect the fine-adjustment, is open to question, for the different photographed planes when developed must overlie each other and tend to confusion, except with very simple objects. It has been usual to find the most perfect visual focus of whichever plane gives the truest aspect of the whole, and to photograph that, using a rather slow plate, a low angle objective, full exposure, and slow development well restrained.

HITCHCOCK, R.—**Photomicrography.** IX.
[Sensitizing the paper, printing, mounting, &c.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 41–4.

(5) Microscopical Optics and Manipulation.

Magnifying Power of Dioptric Instruments.—M. A. Guébhard * has cleared up the disagreement which appeared to exist between theory and practice in regard to magnifying power.

Magnifying power involves a comparison between the apparent size of an object seen with and without the optical instrument, by apparent size being meant the size of the image on the retina. This is proportional to the visual angle (or its tangent), that is to say, it may be measured by $\frac{h}{d}$ where h is the absolute size of an object and d its distance from the first nodal point of the eye. The apparent size may therefore be increased indefinitely by bringing the object near the eye, until the *punctum proximum* or least distance of distinct vision is reached. Defining then the magnifying power as the ratio of the visual angles under which the object is seen, with and without the instrument respectively, when the conditions are as

* Rev. Scientif., 1883, pp. 804–11 (5 figs.). Transl. by G. Fischer, Central-Ztg. Optik u. Mech., v. (1884) pp. 183–8 (6 figs.), 194–7. Cf. also pp. 217–20 (3 figs.).

favourable as possible, we get $P = \frac{H}{D} : \frac{h}{d}$; H being the size of the image and D its distance from the nodal point. Putting $d = 1$, that is, choosing for unit length the distance of distinct vision of the eye under consideration, we may write $P = \frac{H}{h\,D}$. Now if δ = distance between the second principal plane of the instrument and the nodal point, f = distance between the second principal focus and the second principal plane $\frac{H}{h} = \frac{D + \delta}{f}$.

Hence $P = \frac{1}{f}\left(1 + \frac{\delta}{D}\right)$.

This is the formula which in different shapes appears as the expression for the magnifying power; but an unjustifiable limitation is generally imposed upon it by rejecting negative values of δ and D. As a matter of fact δ is generally negative. (Supposing the eye at the left-hand side of the page and looking towards the right, the positive direction is here taken as from left to right, negative from right to left, the nodal point being origin.) If δ and D were always positive P would be increased by increasing δ and diminishing D, i. e. by bringing the eye as close as possible to the eye-piece, so that the image is produced at the *punctum proximum*. The fact that this is not done in practice is generally explained on physiological grounds. The eye is withdrawn from the lens, it is said, so as to avoid the prolonged effort of accommodation. M. Guébhard, on the other hand, maintains that accommodation is relaxed simply because in most cases nothing is gained by it. It will be seen that D may have any value between the *punctum proximum* and the *punctum remotum*, i. e. between the greatest and least distances of distinct vision, and the former may be equal to ∞ for emmetropy and even negative for hypermetropy. As regards δ, it is in general physically impossible to bring the nodal point nearer to the instrument than 12 mm., and few instruments have a longer focal length than this, so that δ is generally negative.

The author then discusses the interpretation of the formula in the different cases which may arise according as D is + or −, and greater or less than δ. With the Microscope, for example, where δ is negative, D positive, and δ numerically less than D, δ must be as small and D as large as possible, that is to say, the eye must be brought close to the eye-piece, but accommodation must be relaxed, *so that vision takes place at the greatest, and not, as is generally stated, at the least distance of distinct vision.*

D positive, δ negative, and δ greater than D is the case of the camera obscura, or projection on a screen.

The case of hypermetropy (D negative) is curious; here δ if + must be small, but if negative must be as large as possible, and the instrument will have its greatest power when the eye is withdrawn as far as possible and has the image formed behind it at the greatest distance of distinct vision; the magnifying power continues to increase as the eye is moved farther from the lens, and in this respect hypermetropy is attended with a considerable advantage over every other peculiarity of vision.

The author finally expresses a desire that opticians should determine not only the focal lengths of their instruments, but also the focal positions, so that the actual magnifying power attainable could be calculated from these data and from the physical constants of the eye, instead of assuming, as is generally done, that 250 or 300 mm. represents universally the distance of distinct vision.

Dr. V. Chiusoli points out* that the conclusions of Guébhard can be verified by a simple experiment.

Using the strongest eye-piece and the weakest objective, focus the Microscope upon a coarse object of sharp outline (e.g. hairs). Then, according to Guébhard, the virtual image formed by the eye-piece is at the *punctum remotum* of the eye. Next move the tube suddenly towards the object through a fraction of a millimetre by means of the micrometer-screw; the object at first appears blurred, but after a short effort the details will reappear with their former distinctness. The image in this case has been brought nearer to the eye, and can only be seen clearly again after an effort of accommodation. The movement of the tube must be small, since it will correspond to a large displacement of the image.

In the same way, if the vision be suddenly transferred from one part to another of the same object without any movement of the tube, an effort of accommodation will be necessary, since the different parts of the object do not lie in the same focal plane.

These facts indicate the correctness of Guébhard's conclusions and the error of the impression that the virtual image is always at the least distance of distinct vision.†

Care of the Eyes in Microscopy.‡—Prof. S. H. Gage recommends the microscopist (in addition to keeping both eyes open and using an eye screen if necessary) to "divide the labour between the two eyes, i.e. use one eye for observing the image awhile and then the other."

He considers that "with a Microscope of the best quality and suitable light—that is, light which is steady and not so bright as to dazzle the eyes, nor so dim as to strain them in determining details—microscopic work should improve rather than injure the sight."

KERBER, A.—**Bestimmung der Farbe, für welche die sphärische Aberration zu heben ist.** (Determination of the colour for which the spherical aberration is to be corrected.)

[The author inquires how the aberration should be corrected so that the average spherical aberration of all colours shall equal O, due regard being had to their different intensities; and concludes that this condition is secured when the correction is made for light of wave-length 0·00055, that is, for a ray lying between D and E. It appears, therefore, that this result is practically realized by the correction as it is ordinarily made.]

Central-Ztg. f. Optik u. Mech., VIII. (1887) pp. 49–51.

NELSON, E. M.—**Microscopical.**

[Reply to queries on optical tube-length; tests for spherical aberration in objectives, with remarks on the fallacy of the American system of testing; stages, &c.]

Engl. Mech., XLV. (1887) p. 221.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XVII.

[Diffraction, Ancient and Modern.] *Engl. Mech.*, XLV. (1887) p. 93 (1 fig.).

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of Lens-systems.) 8vo, Tübingen, 1887.

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* Rev. Scientif., 1884, p. 62. Cf. Zeitschr. f. Wiss. Mikr., i. (1884) pp. 558–9.

† Prof. C. M. Gariel (Rev. Scientif., 1883, p. 789; Central-Ztg. f. Optik u. Mech., v. (1884) pp. 218–9, 3 figs.) gives an elementary proof of Guébhard's results, showing that if the focus lies behind the nodal point the magnifying power increases as the image approaches the eye, and is greatest at the *punctum proximum*. If the focus is in front of the nodal point the magnifying power increases as the image recedes, and is greatest at the *punctum remotum*. If the focus coincides with the nodal point the magnifying power remains constant. Cf. on same subject, Monoyer; Comptes Rendus, xcvi. (1883) pp. 1785–7; Central-Ztg. f. Optik u. Mech., v. (1884) pp. 217–8.

‡ 'Notes on Microscopical Methods,' 1886–7, pp. 8–9.

(6) **Miscellaneous.**

Relations between Geology and the Mineralogical Sciences.*—Prof. J. W. Judd in his anniversary address to the Geological Society made the following remarks on the Microscope.

"How is it, we may profitably ask, that the biological sciences have made such prodigious advances, while the mineralogical ones have lagged so far behind? We must ascribe the result, I believe, to two causes:—

In the first place, improvements in the construction of the Microscope, and more especially the perfecting of methods of study by means of thin sections, have immeasurably enlarged the biologist's field of observation; histology and the cell-theory, embryology with all its suggestiveness, and many important branches of physiological research, must have languished, if, indeed, they ever saw the light, but for the aid afforded by the microscopical methods of inquiry.

In the second place, the growth of geological and palæontological knowledge has been the leading factor in that profound revolution in biological ideas which, sweeping before it the superstition of fixity of species, has endowed this branch of natural science with the transforming conception of evolution.

Now these two causes, which have done so much for biology, are already working out the regeneration of mineralogy; and I doubt not that the fruits brought forth by the latter science will be equally satisfactory with those of the former.

The application of the Microscope to the study of minerals has proved less easy than in the case of animal and vegetable structures. . . .

The greatest step in advance in connection with the microscopic study of rocks was undoubtedly made, however, when it was shown that transparent sections of minerals, rocks, and fossils can be prepared, comparable to those so constantly employed by biologists in their researches. . . .

I believe that what geology has already done for biology she is now accomplishing for mineralogy; it may, indeed, be instructive to point out how, in every one of its departments, the employment of microscopic methods and the suggestion of new lines of thought are causing mineralogy to develope in just the same directions as biology has already taken before her. In this way we may perhaps best convince ourselves that mineralogy is once more asserting her position in the family of the natural sciences."

The Microscope in the Legal Profession.†—Under this heading the editors of 'The Microscope' write as follows:—

"The importance and usefulness of this great instrument grows with every year. Its valuable service is by no means restricted to the medical profession, whose especial favourite it is. It has interested itself in the varied fields of manufacture, especially in pharmacy and chemistry, where it has become as indispensable an article of furniture as the mortar and pestle to the apothecary; but its orbit has widened and continues to widen with almost every new moon.

"It is, perhaps, not generally known how very useful it has of late years become in the legal profession. A few years ago, when a question arose as to the authenticity of signatures, or suspected alterations in a written instrument (such as deeds, wills or promissory notes), the only means the court and jury had to settle the vexed question was to call in men reputed to be 'experts' in the matter of handwriting, such as bookkeepers, paying-tellers in banks, scriveners and copyists, and take their opinions

* Quart. Journ. Geol. Soc., xlii. (1887), Proceedings, pp. 60–2.
† The Microscope, vii. (1887) pp. 81–2.

for what they were worth. Oftentimes very shrewd judgments were given by such witnesses; but the best opinion in a delicate case was generally submitted as a mere guess or conjecture, with such reasons as the observer had to offer in its support, and smart lawyers generally managed to introduce as many expert witnesses on one side as were offered on the other, and so the jury, instead of being helped, were only the more perplexed over the question which they were sworn truly and correctly to decide. The rule of law being that any *material* alteration in an instrument rendered the entire document void, it will be seen how large interests of contending parties were often suspended on the correctness of the human eye—unaided, it was as difficult a task in many cases as for the observer to tell by a glance the number of fibres in a leaf, or threads in a fabric offered for inspection. In cases of forgery, the freedom or imprisonment of the suspected party was made to turn on the stumbling judgment of unlettered and unskilled men in the jury-box. But to-day, in all such cases the Microscope is summoned into court, and its silent testimony solves the riddle in almost every case. There is no impeaching this expert witness. Call as many Microscopes to the witness stand as may be desired, they all tell the same story—no conflict between them, and the case is settled beyond the possibility of a doubt. In the matter of counterfeited currency the Microscope has become a *vade-mecum* to every modern bank clerk charged with the responsibilities of a receiving teller. If a glance of his well-trained eye awakens a suspicion as to the genuineness of a Government note, he has but to place it under his Microscope and his doubt is made a certainty. His testimony, therefore, in behalf of the Government against the counterfeiting engraver fixes his destiny at once. The relations which the Microscope sustains to medical jurisprudence are none the less important, indeed, they are still more valuable because there they bear upon human life instead of human liberty merely. The criminal whose garments are stained with human blood can no longer relieve himself of a suspicion by saying they were discoloured by the blood of a slaughtered sheep or calf. The Microscope looks down upon them, searches out the corpuscles and renders its verdict at once as to whether the prisoner wears the badge of murder or whether he should go free. Also in all the variety of criminal cases in which poison is suspected and where felonious miscarriage is charged, the Microscope is now a swift and essential witness in ascertaining and settling the exact facts—indeed, it has become as indispensable to the legal profession as to the medical, as might be yet more conclusively here demonstrated had we space in which to expand this article.

"We leave the subject with the remark, that in the whole realm of science there is no instrument yet discovered that, in practical usefulness, can compare with the Microscope, and therefore it is we who are inspired to promote and expand its sphere of science in the cultured and civilized world."

Captain W. Noble and this Journal.—We once asked a paragraph writer for a periodical how it was that he and his brother professionals so frequently wrote such utterly inane paragraphs, about nothing in particular or on such absurdly minute points that they could be of no interest to any human being. His answer was that no one who had not had practical experience in the matter could realize the shifts and difficulties to which the paragraph writer was put. The day of publication came round with the clock and the inexorable employer with equal regularity demanded the prescribed amount of copy, and allowed no delays and no

excuses, so that vacant space had to be filled with nothings if the somethings were wanting.

It is evidently under this influence that Captain William Noble (F.R.A.S. and one of the Fellows of this Society), who writes paragraphs fortnightly for the 'English Mechanic' under the *nom de plume* of "A Fellow of the Royal Astronomical Society," has published a series of notes on this Journal.

Last year Captain Noble apparently wanted to know why the index was not published in December. The obvious way of obtaining the information he wanted, being a Fellow of the Society, was to apply to one of the officials, who would, of course, at once have given it. This would not, however, have supplied any paragraph to fill a vacant space, and accordingly Captain Noble put his inquiry into print, and published it as one of his paragraphs.*

The officials of the Society very properly paid no attention to such an extraordinary proceeding, and "One Who Knows" somewhat unmercifully criticized † Captain Noble for the absurdity of which he had been guilty, and invited him next time to inquire before rushing into print, a suggestion which (perhaps not unnaturally) considerably irritated Captain Noble, who complained ‡ of the "elephantine chaff" to which he had been subjected.

This criticism, nevertheless, made, as it was intended to do, an impression on the worthy Captain, and when this year the index did not make its appearance, he wisely decided that he would inquire before committing himself as he had done in the previous year, and so avoid again falling under the sarcasm of "One Who Knows." When Captain Noble presented himself at the Library to make his inquiry, as his ill luck would have it, the Librarian was absent. What ought any one to do under such circumstances who was really desirous of obtaining an answer to his inquiry? Obviously, if he could not wait until the Librarian returned, he would leave his inquiry as a message or a note, and request a reply to be sent, as it would have been. He would *not* take the first answer he could get—from no matter whom—the more absurd the better—and rush off with it to the printer. Yet this is just what was done by Captain Noble, who, amongst other statements, said § that the result of his inquiry was that he "was informed by the attendant that 'he *didn't know*, but *perhaps* " Mr. Crisp had been too busy to attend to it!' "

The italics in the above quotation are ours, but it hardly requires such marks of accentuation to call attention to the character of the "explanation" which Captain Noble was content to carry away with him for publication!

No notice being taken of this, Captain Noble indited another paragraph, in which he said ‖: "Verily, if there be any foundation for the quasi-explanation vouchsafed to me at King's College, Mr. Crisp must have been oppressed with an amount of business almost appalling to contemplate."

These paragraphs were again criticized by "One Who Knows," who again pointed out ¶ the childishness of Captain Noble's proceeding, and also stated that he had made personal inquiry at the Library of the Society, and that both officials certified that not only did they not give such an answer as alleged, but that no such inquiry, verbal or written, was addressed to them.

This letter irritated Captain Noble still more than before, and induced him to write in terms ** which it would be unfair to print here, as we are sure he regretted his paragraph as soon as he saw it in print. It is never

* Eng. Mech., xlii. (1886) p. 446. † Ibid., p. 474. ‡ Ibid., p. 489.
§ Ibid., xliv. (1887) p. 560. ‖ Ibid., xlv. (1887) p. 173.
¶ Ibid., p. 201. ** Ibid., p. 219.

wise to write in anger, and still less to print what is thus written, and Captain Noble's letter is a striking example of this. In addition to charges of "impudence" and a reflection on the Council for which there was no foundation, the letter contained the assertion that the period from the middle of February to the middle of April was *four* months, which sufficiently shows the state of mind in which it was written.

The unkindest cut of all came, however, not from the enemy, but from a friend, Captain Noble's own editor, who after very impartially publishing a further letter * from "One Who Knows," closed the discussion with the following remark:—

> "This ends this matter. Our space is too precious to devote to "the endless discussion of the merits or shortcomings of other "publications of no interest to one in a hundred of our readers."

We are sure every Fellow will agree in the very sensible view of the editor, and it is only left to wonder why when Captain Noble had such a plain course open to him, he should have adopted one which exposed him to the well-deserved criticism we have quoted.

The matter, moreover, does not end with the manifestation of its puerility. Never having troubled to obtain an answer to his inquiry, Captain Noble remained in ignorance of the cause of the delay in issuing the index, and hence was led to deal with the matter in a way which he would otherwise not have done, thus exposing himself to be considered not a little inhumane, though we are sure such a charge would in reality be unjust. Whatever his temperament, we are satisfied he would be among the last to, for instance, dance a *pas des fous* at the funeral of his neighbour. We are gratified to know that we have the sympathy of such of the Fellows as are aware of the cause of the delay, and notwithstanding the justification which Captain Noble has given for supposing the contrary, we are sure that if he had only taken the same trouble to get an answer as he did to ask the question we should have had his sympathies also. We only cite the fact to show how more than ridiculous his proceeding has been, whether looked at from the light of his position of a Fellow of the Society or even as an outsider.

In writing these lines we have had no desire to press harshly upon Captain Noble. Though we cannot flatter ourselves that (at the moment at any rate) he will pay much heed to any remarks from ourselves, we have certainly a hope that the expression of opinion from his own editor will have more weight, so that he may not find himself again in such an undignified position. Our object in writing is similar to that which suggested in olden times the fixing of the heads of misguided persons on Temple Bar. They, poor wretches, were beyond the influence of example. The ghastly display was solely intended *pour encourager les autres.* If others are tempted to enter on such a proceeding as that on which we are now commenting, we invite their perusal of this note and ask them to consider the moral it points before launching on the world in print a discussion "of no "interest to one in a hundred of their readers."

BERNARD, J. G.—**Histoire des Microscopes; ce que leur doit la Médecine.** (History of Microscopes; what Medicine owes to them.)

[I. 1. History of simple Microscopes, the solar Microscope, and compound Microscopes, before achromatism. 2. Construction of lenses, achromatism, methods of illumination. 3. Simple and compound Microscopes after achromatism. 4. Accessories. II. 1. What Medicine owed to the Microscope before Schwann. 2. And since Schwann. Recent discoveries, future of medicine.]

iv. and 145 pp. and 1 pl., 8vo, Paris, 1886.

* Eng. Mech., xlv. (1887) p. 242.

Boys, C. V.—**On the production, preparation, and properties of the finest Fibres.**
[Fibres less than the 1/100,000 in. in diameter were obtained from quartz.]
Nature, XXXV. (1887) p. 575.

Fraunhofer, Joseph von, zur Säkularfeier seines Geburtstages.
[Sketch of his life, with portrait. Born 6th March, 1787. Died 7th June, 1826. "Achromatic lenses for Microscopes were made in his workshop; a large Microscope completed in 1816 was furnished with a peculiar measuring apparatus to the screw-micrometer, which allowed the diameter of objects to be determined to the 1/100,000 of an inch."]
Central-Ztg. f. Optik u. Mech., VIII. (1887) pp. 73–5 (portrait).
Cf. *Zeitschr. f. Instrumentenk.*, VII. (1887) pp. 113–28 (portrait).

Glass, the New.—Yet other variations of the ludicrous accounts of this glass.
["Professors Abner and Schott have invented a new optical glass, which will be of great value in microscopic photography. It is said that while the ordinary lenses do not admit of distinct reflections beyond 1/500,000 of an inch, this new glass will render 1/204,700,000th of an inch visible."]
Family Doctor, 1887, p. 66.
["As an instance of how a grain of truth may sometimes be transformed into a mountain of error, the Secretary read an item which has been going the rounds of the interior press, and which announced the discovery of a new glass in Sweden, composed principally of boron and phosphorus, of such extraordinary refractive power that lenses made of it would reveal the 1/204,700,000 in."]
Proc. San Francisco Micr. Soc., 13th April, 1887.

Journal of the Royal Microscopical Society—retrospective and prospective.
[Review of this Journal.] *Nature*, XXXVI. (1887) pp. 78–9.

Mayall, J., Jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) *Contd.*
[*Transl.* of the Cantor Lectures. See Journal, 1886, p. 869.]
Journ. de Microgr., XI. (1887) pp. 113–24 (12 figs.).

Pelletan, J.—**Nos Maitres.** Charles Chevalier.
[Memoir and portrait.] *Journ. de Microgr.*, XI. (1887) pp. 177–8 (portrait).

Rogers, W. A., Hon. F.R.M.S.—[Sketch of Life.]
The Microscope, VII. (1887) pp. 45–80 (portrait).

V., O.—Messrs. Schott & Co.'s new Optical Glass.
[Remarks on the table of optical data referred to in Journal, 1886, p. 856.]
Engl. Mech., XLV. (1887) p. 249 (in part).

Williams, G. H.—**Modern Petrography:**—An account of the application of the Microscope to the study of geology.
[Contains a note upon Petrographical Microscopes.]
35 pp., 8vo, Boston, Mass., 1886.

Williamson, W. C.—**The Microscope and Geology.**
[Abstract of Presidential Address.]
Rep. and Proc. Manchester Sci. Stud. Assoc. for 1886, p. 32.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Method for Preservation and further Cultivation of Gelatin Cultures.†—Dr. H. C. Plaut preserves gelatin and agar cultivations in the following manner.

If a plate cultivation, the colony is cut out with a fine sterilized knife, and placed on a sterilized slide in a drop of sterilized water to which a trace of glycerin has been added. The slide is then warmed over a spirit-lamp, and a sterilized cover-glass imposed, which is fastened down with some varnish. This procedure will allow the colony to be examined at any time under high powers, and the original condition of the cultivation will be retained for quite a year. If required for cultivation in other media the colony is always available by merely removing the

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Fortschr. d. Med., iv. (1886) p. 419.

cover, and if, instead of water, some nutrient medium be used, anaerobic bacteria can be developed in the chamber.

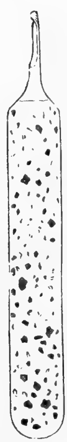
For test-tube cultivations, after the glass has been washed outside with a 2 per cent. sublimate solution, it is scratched round at the level of the gelatin with a file and then broken off. From the gelatin a colony is dug out with a sterilized knife, and treated as above.

In this way tube cultivations become accessible to the Microscope and to photomicrography. Agar cultivations may be treated in a similar manner, but stronger heating is required. A mixture, however, of equal parts of meat-peptone-gelatin and agar-meat-peptone produces a mass which is fluid at 48° C. and can be preserved at 28° C.

Modification of Koch's Plate Method.*—Dr. R. J. Petri recommends flat double vessels of 10–11 cm. in diameter, and 1–1·5 cm. in height. The one used as the cover, of course, is a little larger. The gelatin, prepared in the usual manner, is poured in so as to form a layer of only a few millimetres thick, and then the cover imposed. A level layer is easily obtained by gentle to and fro movement. Except the edge, every part of the gelatin is accessible to the Microscope. The gelatin dries very slowly, and may be kept damp for a long time by putting several of these small vessels within a large one, with a piece of damp filter paper, and then covering with a bell-jar. These vessels answer very well for agar plates. Numbering the colonies is very simple. The cover is replaced by a glass plate marked out in divisions, through which the position and number of the colonies are noted.

FIG. 146.

FIG. 147.



Method for Cultivating Anaerobic Bacteria.†—Dr. M. Gruber uses a tube made of easily fusible glass; it is about 25 cm. in length, and the wider part about 2 cm. in diameter. The neck, about 5 cm. long, is only 3–4 mm. wide (fig. 146). After having been plugged with cotton wool and sterilized in the usual manner, the lower part or body receives 10–12 cm. of gelatin, introduced with the usual precaution, and is then again sterilized at 100°.

After having been inoculated by the aid of a platinum wire, the cotton-wool plug is rammed down tightly and a caoutchouc plug, with a piece of rectangular glass piping, is fitted into the head. The glass piping is connected with an air-pump, and the air exhausted as far as possible; the residual air is removed by immersing the tube in water at 30°–35°, and boiling. The contents of the tube are prevented from bubbling up by gently heating the junction of the neck and body with a Bunsen's burner. The evacuation and boiling occupy about a quarter of an hour.

* Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 279-80.
† Ibid., pp. 367–72 (2 figs.).

While the boiling is still going on, the neck is heated and melted off (fig. 147). The tube is then laid in a horizontal position and rotated, so as to spread out the gelatin into a regular layer, and care must be taken to allow it to cool gradually. With practice, the whole transaction does not take more than twenty to twenty-five minutes.

The author remarks, that the addition of sugar renders meat-peptone gelatin a more suitable medium for anaerobic bacteria.

The foregoing method is only intended for the cultivation of such bacteria as will thrive at temperatures under 24°–25° C., but the tubes may be filled with agar or fluid media, and used for the examination of the fermentation properties of anaerobic organisms.

New Method for the Cultivation of the Tubercle Bacillus.*—MM. Nocard and Roux advise the use of sterilized serum, which is obtained from the jugular vein of an animal (horse for choice). The blood is passed aseptically into large sterilized bulbs, and then coagulated in fresh water at 10°–12°. The serum is withdrawn with Pasteur's ball-pipettes.

M. Nocard had previously determined that coagulated serum is rendered more suitable for the cultivation of the bacillus by the addition of peptone, soda, and sugar, and the authors now advise the addition of 6–8 per cent. glycerin, which, they state, prevents the formation of the iridescent scum on the surface of the serum from drying and oxidation, and even favours the growth of the bacilli.

Tubercle bacilli were found to grow well in agar-bouillon at 39° if 6 to 8 per cent. glycerin be added to this medium.

The cultivations in media thus prepared grow more luxuriantly and rapidly than by other methods, while they retain the staining and physiological properties characteristic of tubercle bacilli.

Pure Cultivation of a Spirillum.†—Dr. E. Esmarch has succeeded in obtaining a pure cultivation of *Spirillum* from the dried-up remains of a mouse which died of mouse septicæmia. A trace of the remains was inoculated in gelatin, and from this a second tube prepared according to Koch's fractional method.

In the first tube more than 200 colonies of bacteria appeared within a few days. These, which did not liquefy the medium, were of a yellowish-grey colour, and in the course of another fortnight or so assumed a wine-red hue. In the attenuation tube two colonies of bacilli soon showed themselves, and after the lapse of fourteen days four new colonies appeared. These were found to be identical with the red colonies in the first tube. Cover-glass preparations showed that the colonies were a pure cultivation, and consisted of short *Spirilla*.

Cultivated in meat broth, the *Spirilla* were found to flourish best at a temperature of about 37° C., copious development taking place within twenty-four hours. At ordinary temperature eight to ten days were required.

In the original cultivation short *Spirilla* only, with two or three turns, were noticed, but in the broth the number of turns became greater, amounting to thirty, forty, and even fifty. The thickness of curve was always the same, being about double that of the cholera *Spirillum*. The short ones showed lively movements; the larger were either motionless or moved in a slow snake-like way. Cover-glass preparations were stained with the ordinary watery anilin dyes for above five minutes. No flagella were rendered evident.

* Ann. Instit. Pasteur, i. (1887) pp. 19–29.
† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 225–30.

In respect of colour this *Spirillum* was found to differ from other pigment-forming micro-organisms, since access of air was not found to be a requisite, for the red pigment appeared in the deeper layers of the gelatin while the superficial were still devoid of colour. Agar, blood-serum, potato and milk also formed favourable surfaces for the development of this organism.

Examined in hollow-ground slides, the cover-glass of which was supplied with gelatin, the *Spirilla* were found, after ten minutes in the incubator, beginning to show signs of division, and in twenty-four to thirty hours the threads were distinctly separated into segments equal to about three-quarters of a turn, and these segments again, in another twenty-four hours, began to grow so luxuriantly that the colony appeared like one vast coil. Solid media seemed to be more favourable to the production of the shorter forms, and in colonies developed on agar or potato, resting forms, or possibly actual spore formations, became evident. Bright uncolourable spaces, like the spores of anthrax, were seen in cover-glass preparations, and though they could not be differentiated from the rest of the body-wall by staining, they may perhaps be regarded as the resting phase of the *Spirillum*. For when the *Spirillum* was dried on silk threads they were found to be dead in 6–8 days, and no growth took place in gelatin. But the spore-like forms, when dried for five weeks, were capable of developing in broth at a temperature of 52° C. within five minutes.

Experiments on animals which were injected with some of the pure cultivation gave negative results.

For this *Spirillum* the author suggests the name of *S. rubrum*.

New Culture Medium.*—Dr. A. Edington says that a jelly derived from Irish moss is much less opaque than agar-agar, and more nutritious, and is therefore to be recommended as a culture medium for micro-organisms capable of withstanding high pressure. He macerates 2 oz. of the finest selected Irish moss in 18 oz. water, and after leaving it for a night, keeps it in the steam sterilizer at about 212° Fahr. for an hour and a half, stirring occasionally. It is then strained through a felt bag two or three times, when the jelly thus obtained will be found on cooling merely to gelatinize, yet able to withstand a temperature of 87° Fahr. before liquefying; but if it is evaporated it is found to be capable of withstanding a temperature between 122° and 131° Fahr. before liquefying. In this state, if a test-tube be filled with it, it is found to present the appearance of water with only a slight degree of haziness. In order to render this more nutritious, and so better fitted for the requirements of the growth of the generality of micro-organisms, the materials recommended by Dr. Klein may be added, namely, beef-peptone and ordinary cane-sugar. Add to the jelly 2 per cent. of the former and 1 per cent. of the latter, and the result is a jelly almost as bright as nutrient gelatin and infinitely more so than agar, while the simple method of preparation and the price have much to recommend it.

Collecting Urinary Sediment for Microscopical Examination.†—Dr. C. W. Dulles uses a straight glass, and not a conical one as usually recommended, and leaves the urine to settle for 24 hours. After this time he perforates the paper cover of the glass with a pipette employed in the ordinary manner, and leaves the pipette, also covered or plugged, for another 24 hours. He then withdraws it, and uses the first two or three drops for examination.

* Engl. Mech., xliv. (1886) p. 151.
† The Microscope, vii. (1887) pp. 85–6, from Med. News.

ABBOTT, C. A.—**An improvement in the method of preparing Blood Serum for use in Bacteriology.** *Med. News*, 1887, pp. 207–8.

BOLTON, M.—**A Method of preparing Potatoes for Bacterial Cultures.** *Med. News*, 1887, p. 318.

LOCKWOOD, S.—**Raising Diatoms in the Laboratory.** *Journ. New York Micr. Soc.*, II. (1886) pp. 153–66 (2 pls.)

(2) Preparing Objects.

Notes on the Technique of Embryology.* — Dr. H. Henking finds that the eggs of Phalangida can be kept through the winter without getting covered with fungi, and so damaged or even destroyed, by placing them in an ordinary oven on sand or earth kept moistened with distilled water. The usual antimycotics, such as carbolic and salicylic acid and alcohol, are quite unreliable.

Ova are best preserved with boiling water and chrome-osmium-acetic acid, and Perenyi's fluid is also useful, but sublimate, chromic acid, picro-sulphuric acid, 20 per cent. nitric acid are less reliable. Eggs of Phalangida being little penetrable by reagents, it is almost indifferent whether boiling water or a boiling 1/2 per cent. solution of chromic acid be used for hardening.

Owing to the difficulty of staining eggs the author prefers to rupture the shell. This is done by means of two very sharp needles under a power of 40 or 50 diameters and in 70 per cent. spirit. The eggs are previously hardened in 90 per cent. alcohol, and when transferred to the weaker spirit are easily lacerated without damage to their contents. The outer casing only of the shell is broken; this, the more brittle, is covered with a uterine secretion to which foreign bodies are frequently attached, so that there is an extra advantage in removing it. The more flaccid inner shell serves to protect the egg contents.

The eggs are stained *in toto* best with Grenacher's borax-carmine or with eosin-hæmatoxylin, or with Hamann's neutral acetic carmine. If eosin-hæmatoxylin be used, the eggs are washed with a weak alum solution and then transferred to alcohol which is faintly stained with eosin in order to prevent loss of colour. Ova treated with borax-carmine are overstained and then decolorized in slightly acidulated 70 per cent. spirit.

After having been stained and dehydrated the eggs are transferred to a mixture of equal parts of bergamot oil and alcohol for some hours, then to pure bergamot oil, and from this to a mixture of bergamot oil and paraffin. They are next saturated in paraffin at a temperature of 55° C., and when ready are fished out with a spoon and allowed to drop into a vessel filled with cold water in order to cool the paraffin rapidly.

Orientation of the ovum is most easily effected by means of a glass ring 2 mm. high. This is placed on a slide and filled with melted paraffin, in which the eggs are immersed. The slide is then placed under a dissecting Microscope with a power of 40 or 50 diameters, and the egg moved into the desired position by means of a needle heated in a spirit-lamp. Though manual dexterity is required for this operation, it is more simple and easier than to employ the apparatus devised for this purpose. The paraffin block when cool is easily removed from the ring, and is then melted on to a cork.

The treatment of brittle sections, more especially in the case of Arthropoda, is always difficult. The usual methods for obviating the tendency to crumbling are to brush the section surface over immediately before cutting with collodion or with collodion thinned down with ether.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 470–9.

Dr. Henking, however, finds that ether evaporates too rapidly, and instead uses absolute alcohol for dissolving paraffin. A sufficiently strong but delicate layer is deposited on the section surface by the evaporation of the spirit. If, however, the objects should be extremely brittle, e. g. the eggs of Phalangida, a weak solution of shellac in absolute alcohol and saturated with paraffin should be used. The solution is kept in a stoppered bottle, 8 cm. high, and to the cork are fastened coarse hairs reaching to the bottom of the bottle; by these means fluid sufficient is withdrawn for smearing the section surface.

The removal of air-bubbles, said to occur after mounting in chloroform-balsam, especially when rather thin, may be effected by applying a little pure chloroform at the edge of the cover-glass before adding more balsam.

Method for isolating Epithelial Cells.*—Dr. P. Schiefferdecker, who has employed the process successfully for some years, recommends "Pankreatinum siccum" as an isolating agent for the cells of cuticle. It is a brownish powder made from the pancreas without the aid of chemicals. So much of the powder as will dissolve in cold distilled water is used to the extent of some cubic centimetres. After filtering, pieces of skin are placed therein, and the vessel put in an incubator or some warm place, near but not exceeding the body temperature. Maceration is sufficiently advanced in three or four hours. The pieces are then washed and afterwards placed for preservation in a mixture of equal parts of glycerin, alcohol, and water.

The epithelial cells are easily separated, and their characteristics well preserved.

Demonstration of goblet cells in bladder epithelium of Amphibians.† In his study of the unicellular glands or goblet-cells in the bladder epithelium of Amphibians, Dr. J. H. List used the following methods. For demonstration, nitric acid and silver oxide (1 : 300), and 1/2 per cent. osmic acid for 12–24 hours, with subsequent clearing in dilute glycerin. For hardening, besides osmic acid, 1/4 per cent. chromic acid, 90 per cent. alcohol, and Müller's fluid. Imbedding in paraffin or celloidin. Staining with hæmatoxylin and various anilin dyes—eosin, methyl-green, anilin-green, Weigert's Bismarck brown, nitric acid, rosanilin, dilute Renaut's hæmatoxylin glycerin, and double stains. For isolation, Müller's fluid or 1/2 per cent. osmic acid.

Preparing the Liver.‡—For the examination of the finer structure of the liver-cells Prof. L. Ranvier recommends osmic acid (1–100). He takes pieces of liver (2 mm.) of a freshly killed animal, and leaves them in the fluid for twelve to twenty-four hours. By teasing out, the liver-cells are easily isolated. The excavations on the margins of the cells are not rendered visible by this means, so in order to fill the liver capillaries the author injected the portal vein with a gelatin solution at 30°. The isolated liver-cells were stained either with iodized serum (prepared from the amniotic fluid of a ruminant to which iodine had been freely added), or with "iodide of iodine" (aq. dest., 100; iodide of potassium, 1; iodine crystals in excess).

In order to study the glycogen of the liver, the author employed the following method:—In order to collect as much glycogen as possible in

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 483–4.

† Arch. f. Mikr. Anat., xxix. (1887) pp. 147–8.

‡ Journ. de Microgr., ix. (1885) pp. 3–14, 55–63, 103–9, 155–63, 194–201, 240–7, 287–95, 334–43, 389–96, 438–45, 480–2; x. (1886) pp. 5–10, 55–8, 160–6, 211–4. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 247–51.

the liver-cells, a dog was fed for two days on boiled potatoes to which fat had been added to make them tasty. The animal was then killed, and pieces of the still warm liver were cut with a freezing microtome. The sections were placed in iodized serum and immediately examined. Glycogen was found by this method to be disposed diffusely in the liver-cells, the contents of which had assumed a brown colour. At first the glycogen collects in small irregular masses, but afterwards appears on the cell-surface as lumps stained by the iodine. In sections exposed for some minutes to the vapour of osmic acid the glycogen is fixed within or without the liver-cells without taking on the characteristic wine-red iodine reaction. This staining of the glycogen is unfortunately not permanent, for it begins to disappear in 24 to 48 hours. After leaving the sections in iodized serum for 24 hours, no more glycogen is found.

As an injection mass for the liver vessels Ranvier used gelatin and prussian blue (gelatin, 1·0; prussian blue, 25·0); and also carmin. The gelatin is softened in water, and all the water not imbibed is poured off. It is then dissolved in a water-bath, and to it is added a carmin solution prepared as follows:—Over some carmin No. 40 is poured water sufficient to saturate it. When after standing some hours it has assumed a pappy consistence, ammonia is added drop by drop until the carmin is dissolved. So much of this carmin solution (a very small quantity) is added to the gelatin as will give it the required colour. This mixture is then neutralized by the addition of some drops of acetic acid (1:2 or 3 parts water). Neutralization is shown by the appearance of the wine-red colour. The mass is then filtered through flannel into the injection syringe. (If the temperature of the animal amounts to 36°, there is no diffusion of the injection mass through the vessels, on account of the large quantity of the gelatin.) After cooling, the liver is cut into small pieces of 1 cm. breadth and placed for 24 hours in ordinary spirit. This suffices to render the pieces of liver sectionable.

In order to examine the intercellular substance of the epithelium, the author used the silver method. He exposed the portal vein of a rat just before its entrance into the liver, and in order to remove the blood, injected through a syringe with a silver needle first distilled water, and then after some seconds a silver solution (3:1000). The liver was then placed in distilled water for one or two hours, and afterwards in spirit. On the second day sections were made, mounted in glycerin, and exposed to daylight. After some days they turned brown, and the intercellular spaces became visible.

Prof. Ranvier demonstrates the interlobular connective tissue by hardening pieces of liver in alcohol and staining the sections with hæmatoxylin and picrocarmin. Preparations of the latter were preserved in glycerin to which formic acid was added.

The bile-ducts were injected with Hering's apparatus. With this a mercurial column of 30–40 mm. is advantageous, as with higher pressure slight lacerations of the biliary capillaries occur. The injection mass is prepared by mixing a concentrated solution of the persulphate of iron with a solution of the yellow prussiate of potash. An insoluble precipitate of prussian blue is obtained, but when moistened with water it gradually becomes soluble. A too strong solution should not be used, as it easily precipitates. The injection should be carried out as quickly as possible, and at a low but constant pressure, 40 mm. The animals (rats, guinea pigs, and rabbits) are killed by decapitation, and injected while the liver is still warm. The injection usually only takes one minute. The sections are afterwards mounted in dammar.

In order to show the biliary passages, Prof. Ranvier injected silver solution (1 : 500) into the hepatic duct (in frogs from the gall-bladder) of a recently killed animal (40 mm. pressure). The duration of the injection was three hours. Small pieces of liver were then placed in osmic acid, others in alcohol, and the sections, made in 24 hours, were mounted in dammar or in formic acid glycerin.

The author also employed the "natural" injection. 60 c.cm. of a cold saturated indigo-carmin solution were injected into the jugular of a live rabbit, 15 c.cm. at a time, with 20 minutes' interval between the injections. Ten minutes after the last the animal was killed, and through the portal vein a solution of potassium was injected in order to fix the colouring matter in the biliary canals. Hardening was done in alcohol. Osmic acid is not advisable, as it destroys the blue colour.

Embryonic livers were treated by hardening small pieces for 15 hours in osmic acid, then, after washing, hardening in 40 per cent. alcohol. They were then set in a mixture of wax and oil, and afterwards in elder pith.

When examining the glands of the hepatic duct these were injected with osmic acid (1 : 100). Small pieces were teased out in a physiological salt solution (7 : 1000 aq.). Sections of the hepatic duct stained with picrocarmin were mounted in formic acid glycerin. The glands of the hepatic duct showed up much better with gold chloride than with osmic acid. Freshly expressed lemon juice was injected into the hepatic duct, and 10 minutes later gold chloride 1–100. To reduce the gold, small pieces were kept for 24 hours in formic acid (1 : 3 aq. dest.). The glands were stained a bright violet.

The author then passes to the examination of the gall-bladder (guinea-pig) the epithelium of which he obtained by maceration in iodized serum. Lastly, it may be mentioned that the muscle-fibres of the gall-bladder were demonstrated by injecting therein freshly expressed lemon juice and leaving it therein for five minutes. The gall-bladder is then placed in osmic acid for some minutes, then washed, and the epithelium removed with a brush. Sections stained with picrocarmin show striped muscular fibres.

The Resorcin derivative Phloroglucin.*—Dr. J. Andeer communicates the following interesting properties of phloroglucin or trioxyhydro-benzol. It prevents the coagulation of the blood and other animal juices, keeping them fluid and undecomposed for a long time. In certain fermentations it acts as a deodorizer, but as an antiseptic and antimycotic it is quite useless.

In conjunction with hydrochloric acid it renders bone sectionable in a few hours. (It has, however, no action on elastin or keratin.) The addition of hydrochloric acid to the saturated watery solution of phloroglucin bears a direct relation to the hardness, i. e. to the amount of phosphate, in bone. The acid must be pure, but not fuming. For bones of Batrachia, 5–10 per cent.; of Reptilia and Aves, 10–20 per cent.; of mammals, 20–40 per cent. additions of hydrochloric acid are recommended. The softening of mammalian bones may be hastened by increasing the quantity of hydrochloric acid. After the desired consistence is attained, all trace of acidity must be removed by frequent washing in water, and the preparation treated by any of the ordinary methods of hardening.

The foregoing process has been further elaborated † as follows:—The

* Centralbl. f. d. Med. Wiss., Nos. 12, 33, pp. 195, 579. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 375–6.

† Internat. Monatschr. f. Anat. u. Histol., i. (1886) pp. 350–3.

objects softened by means of phloroglucin and hydrochloric acid are afterwards hardened by one of the recognized methods. As many injection masses are thereby softened, Dr. Andeer recommends, if blood-vessels are in question, impregnating the walls of the vessels with mineral colours instead of injecting their lumen. Injection of solution of ferro or ferridcyanide or sulpho-cyanide of potassium, followed by iron chloride, gives excellent pictures, and the preparations thus obtained are permanent and susceptible of any further treatment.

New Method of Mounting Protozoa in Balsam.*—M. A. Certes describes a new method of mounting Protozoa in balsam, discovered by M. Tempère: the specimens exhibited were of *Ophryoscolex* and *Balantidium* from the paunch of Ruminants. After the organisms have been fixed and coloured they must be passed through alcohol of 36°, 70°, and absolute; the last ought to be renewed at least twice, and should continue to act for about twenty-four hours. The absolute alcohol must then be replaced by pure benzole; a tenth of the alcohol in which the organisms are placed is removed by the pipette, and replaced by the same quantity of benzole; this operation is repeated ten times, at intervals varying from ten to thirty minutes. Care must be taken that the benzole mixes thoroughly; after the last addition it should be decanted, and pure benzole substituted. After twenty-four or forty-eight hours in the benzole, according to the size of the object, a fifth part of Canada balsam dissolved in benzole is added; this is repeated at intervals of from a quarter to half-an-hour; and the organisms may then be preserved in the tubes till wanted, or mounted at once. In mounting care must be taken that each drop holds in suspension a sufficient quantity of organisms.

Microscopical Technique for small Pelagic Objects.†—Prof. J. Brun gets rid of the organic detritus, &c., which accompanies the mud and ooze from which Polycistina, Radiolaria, Globigerina, Foraminifera, and Diatomaceæ are obtained, by heating the dried up mass with weak hydrochloric acid in order to remove the chalk. When the reaction is over the contents of the flask are poured on to a filter and washed. When dry the deposit is treated in a flask with twice its volume of strong sulphuric acid (for guanos 5–6 times this volume of acid is required). After standing some time the upper three-fourths of the acid which dissolves the chitinous débris is decanted off and to the thick black paste is added bichromate of potash in coarse powder until it begins to turn red. By the production of nascent chromic acid the last remnants of organic matter are destroyed; the residuum is then washed at first slowly and afterwards freely and by decantation. The last washings are made with distilled water. The now whitish residue is spread on large cover-glass to dry. Small sea animals may be obtained alive by sweeping them off the surface water in a silk veil fastened to a wire frame. The glairy mass of animals is then at once scraped into a 25 per cent. solution of neutral acetate of potash (solution one quart). The acetate, unlike alcohol, produces no deformity, it prevents decomposition, and is easily removed by washing with water. On the removal of the acetate the mass is treated for several days with cold concentrated hydrochloric acid and the flask frequently agitated. The species are then washed freely and calcined on the cover-glass at a dull red heat. Compact masses of fossil deposit are separated by heating to about 100° and then soaking in a boiling saturated solution of soda sulphate. This salt takes up water as it crystallizes and consequently its dilatation renders the mass

* Bull. Soc. Zool. Fr., xi. (1887), Proc Verb., pp. xix.–xx.
† Arch. Sci. Phys. et Nat., xvii. (1887) pp. 146–54.

friable enough for manipulation after the operation has been repeated once or twice. The mass must never be crushed as a large number of species would be broken.

For sorting and mounting the author uses a low objective (Zeiss *aa* or Seibert No. 1) and a strong ocular. An iron hand-support is fixed to the stage. A pig's or dog's eyelash fixed in a handle is used for picking out. No prism is used as the eye and hand soon become accustomed to the reversed position.

The selected specimens are deposited in a small drop of glycerin-gum lying on the surface of a cover-glass. The gum is made by dissolving 1 grm. of white powdered gum tragacanth in 50 grm. boiling distilled water and then adding to the filtrate an equal volume of pure glycerin. The cover-glasses should be 8–10 mm. in diameter and 1/10 mm. thick.

The selected specimens are arranged on the cover by centering the latter over a circle scratched on a slide. After having been washed with distilled water, the covers are placed in an incubator at 100° (or water-bath) in order to volatilize the glycerin, and hence fix the specimens to the cover.

For mounting diatoms, &c., the author uses balsam of tolu from which cinnamic and benzoic acids have been removed by prolonged boiling in a large quantity of water. It is then dissolved in rectified benzine, filtered, thoroughly dried, and finally dissolved in alcohol or chloroform. When soft the index of this tolu is 1·68, and 1·72 when dry. When the covers are quite dry the tolu thinned with benzine is added and finally a drop of the thicker balsam. The slides are then dried in a stove at a temperature of 60°–70° for an hour or two.

The author decries the artificial (arsenical) media for mounting as the formation of arsenious acid invariably takes place sooner or later and the specimens become useless.

Engelmann's Bacterium-method.—The controversy respecting the value of this method for determining the intensity of the evolution of carbon dioxide is continued by Pringsheim * and Engelmann,† to which Pringsheim ‡ again replies.

Cleaning Diatoms.§—Mr. A. L. Woodward gives the following as an easy and effective method:—

Coarsely powder the diatom-bearing earth, or the dried diatomaceæ, and mix with *bi*-sulphate of potash. Take a porcelain gallipot, about an inch high, and fill it about one-third full of the mixture of diatoms and bi-sulphate; take the tongs and set it down among the glowing coals in the stove. The bi-sulphate immediately begins to fuse, and boils up as black as pitch. If the gallipot is not too full it will not boil over, but rises up and sinks back again and again until, as the sides of the pot begin to turn red the boiling mass becomes clear, and the bottom of the vessel is seen glowing hot through it. When the boiling ceases, lift out the pot and let it cool. Brush off any dirt or ashes that may be on the outside of the pot, and then put it in clean, hot, *soft* water, and let the contents dissolve, which they will soon do. Pour off the water, and replace with clean, soft water, repeating this several times to get rid of the acid. Then shake up in a test-tube, let the sand settle, and pour off the diatoms, repeating this process, also, if necessary.

In the author's hands this process has given very fine results, and

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen. Versamml., pp. xc.–xcvi.
† Bot. Ztg., xlv. (1887) pp. 100–10. ‡ Ibid., pp. 200–4.
§ Scientif. Enquirer, ii. (1887) pp. 70–1.

noxious fumes from boiling acids are avoided. The process was originally suggested by Mr. G. C. Morris, of Philadelphia; he, however, suggested the use of a platinum crucible, which is costly. The porcelain gallipot answers every purpose, while the expense is merely nominal.

Preparing Bacterial Material for Transmission by Post.*—Dr. G. Marzi has devised the following method for transmitting specimens of bacterial material by post, &c.

Square pieces of gelatin leaf, about 14 mm. broad by 25 mm. long, are soaked for five minutes in a 1 per cent. solution of sublimate in absolute alcohol. These having been repeatedly washed in alcohol, are placed under a sterilized bell-jar to dry. A small quantity of the bacterial material (a pure cultivation, blood serum or the like) is then spread with a platinum wire on the gelatin leaf near the edge. When the preparation is quite dry it is rolled in sterilized tinfoil, put in a case and labelled. Two specimens should be sent, one for microscopical examination, the other for cultivation.

The receiver, after having unrolled the tinfoil, rubs the gelatin disc on the surface of a cover-glass moistened with sterilized water. To the cover, the greater part of the bacterial material adheres, and can be used at once after staining, for microscopical examination or for cultivation purposes.

If it be certain that the culture be pure and that the microbes are alive, the second specimen can be used for cultivation on gelatin; if not perfectly pure, the isolation method must be adopted.

Technical Method of Diagnosing Gonococci.†—M. G. Roux recommends the following method of determining the absence or presence of the *Gonococcus* of Neisser, which has hitherto been very difficult. When it is attempted to detect micro-organisms in any organic liquid, the method of double coloration of Gram is generally adopted, that is, after the preparation has been dried and stained by methyl-blue or gentian-violet, it must be submitted to the iodized iodine liquid of Gram, which possesses the property of fixing the anilin colours on the microbes exclusively; the preparation is then decolorized by alcohol, treated with distilled water, and re-stained with eosin; although this method generally succeeds with secretions, it always gives a negative result if *Gonococcus* alone is present. In doubtful cases, then, if *Gonococci* have been recognized on staining by gentian-violet or other reagent without the addition of alcohol, it is only necessary to adopt the method of Gram; if, then, all the cocci disappear they are those of Neisser; if, on the contrary, they or any remain, there must be doubt as to the blennorhagic nature of the secretion.

Preparing Crystals of Salicine.‡—Dr. F. L. James writes as follows:—"Some years ago the writer, after finishing a lot of slides of various crystals for examination under the Microscope, poured a few drops of a solution of salicine on a piece of window glass, and left them to crystallize. Some days afterwards, on examining the glass, he was surprised and delighted at the gorgeous beauty of the crystals. Two of the drops had crystallized so that the glass could be cut away into slides and mounted. These two specimens have been shown annually at the meetings of the American Society of Microscopists, and have been seen and admired by thousands, not one of whom had ever seen their equal. Words utterly fail to give any idea of their splendour. 'Nothing,' said a gentleman at Cleveland, 'short of the Pearly Gates can compare with them.'

Although during the past four or five years I and my students

* Riforma Medica, 1886, No. 21.
† Comptes Rendus, ciii. (1887) pp. 899–900.
‡ St. Louis Med. and Chirurg. Journ., li. (1886) pp. 280–1.

have made many hundred and even thousands of attempts to duplicate these results, up to very recently these two slides have remained unique. After the Chautauqua meeting, where they were again the centre of admiring crowds, I commenced a series of systematic experiments, discarding old methods altogether, and can now announce that I have found a method by which I can get slides, even more magnificent, with absolute certainty; and I have now in my cabinet a dozen, any one of which distances in every respect the old preparations, magnificent and beautiful as they were. I am continuing my experiments with other crystallizable materials, and when they are completed will explain the methods by which the results are obtained. I will say, however, that the size and the form and method of growth of all crystals yet experimented with are modified by the temperature at which crystallization takes place; the degree of saturation of the mother liquor or solution; the position in which rests the slip on which crystallization progresses; the medium used for solution; and, finally, by the material used for retardation of crystallization."

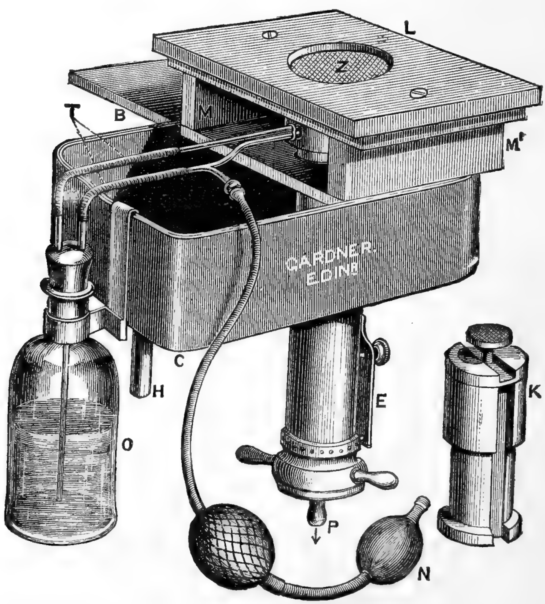
LATHAM, V. A.—**Practical Notes on preparing Palates of Molluscs, Snails, &c.** *Scientif. Enquirer*, II. (1887) pp. 87–9.

TURNER, W. B.—**Desmids.** [Directions for preparing.] *Trans. Leeds Naturalists' Club*, 1886, pp. 16–8.

(3) Cutting, including Imbedding and Microtomes.

Rutherford's Combined Ice and Ether-spray Freezing Microtome.*— Prof. W. Rutherford's well-known microtome is now adapted for freezing

FIG. 148.



by means of an ether-spray apparatus, as well as by the original ice and salt method.

* Lancet, 1885, i. pp. 4–6 (2 figs.).

Fig. 148 shows the instrument as arranged for the spray. The gum-imbedded object placed on the zinc plate Z is frozen by means of a spray of anhydrous ether contained in the vessel O having the tubes T. The superfluous ether runs down through the tube P to a collecting bottle. The spray-tubes are fixed in a slot under Z, so that they are easily removed if required. Instead of the hand-bellows N a pedal pump can be employed. There is an indicator at E. The zinc plate Z is insulated from the surrounding metalwork by means of a vulcanite casing. When used with ice, the glass plate L, the supports M and M′, and the spray apparatus are removed; Z is unscrewed, and replaced by the plug K. The glass plate L is next fitted on the brass plate B, and then the instrument is ready for use. When the box C is filled with the ice and salt mixture the tube H is kept plugged until the box becomes quite full of water. The gum solution is poured into the well and the object immersed therein. The mouth of the well is then closed by means of a guttapercha sheet fixed down by a flat leaden weight, and the whole instrument wrapped up in flannel until the freezing is complete.

A special advantage claimed for this instrument is the facility with which delicate sections are removed from the knife into water, or at once on to the slide.

The knife required for this instrument is of a special construction, and when used is pushed over the glass plate and across the well at a right angle. Hence the knife does not remain sharp very long.

Machine for cutting Rock-sections.*—The machine devised by Dr. H. Rauff does not differ in principle from those which are ordinarily used, but it is provided with adjustments of a new form, by which the rock-specimen may be firmly fixed in any desired position with respect to the cutting-disc. The construction is that of an ordinary turning-lathe, the disc being worked by a treadle and grooved flywheel, while the specimen is held in a support which slides along the horizontal slot of the lathe-bench, and is clamped by a nut from below like the movable rest of a turning-lathe. The rock is held, not by cement as is generally the case, but in a vice capable of holding large fragments: the block which carries this vice is provided with two horizontal rectilinear sliding movements at right angles to one another, one of which is worked by a screw-worm and handle, and the other by a weight acting over a pulley, which keeps the rock in continual contact with the cutting-disc. In addition to these movements the vice-piece can also rotate about a vertical and horizontal axis, and the plate to which it is attached is adjusted and fixed by four levelling-screws. The bearings of the axle and the various parts of the machine are made so massive as to insure greater stability than such machines generally possess.

Sections of Chitinous Organs.†—Herr P. F. Breithaupt, in his investigations into the structure of the bee's tongue, made use of eau de Labaraque (subchloride of potassium), which, after long-continued treatment, dissolves chitin, while it has a preservative action on the neighbouring tissues. The concentrated solution of eau de Labaraque was diluted with three to four parts of water. After washing with water and 35 per cent. alcohol the preparations were hardened by absolute alcohol, cleared up in oil of cloves and imbedded in Canada balsam; those which were adapted for cutting were, after treatment with oil of turpentine, imbedded in a

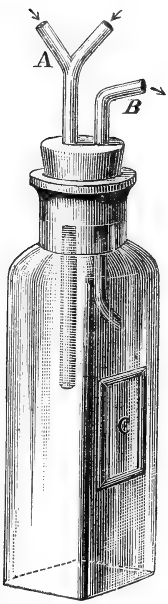
* Verh. Naturhist. Ver. Preuss. Rheinlande, xliii. (1886) Corr. Bl., pp. 130-9 (3 figs.).

† Arch. f. Naturgesch., liii. (1886) pp. 53-5.

paraffin wax mixture, in which were three parts of white wax to one of soft paraffin. The objects were gradually cooled, and sections were made at a temperature of at least 17° R. Schanze's microtome, which is regulated to cut sections from 1/100 to 1/150 mm., was used, and the objects were fixed by Giesbrecht's method. In cutting sections it is important to begin at the hinder end or to follow the direction of the hairs.

Orienting Objects in Paraffin.*—Mr. E. A. Andrews has improved the method of Dr. Selenka † for keeping paraffin melted while the contained small objects are being arranged under the Microscope in any desired position, and then rapidly cooling the paraffin without disturbing the position of the objects.

Fig. 149.



Finding it difficult to make tubes such as Prof. Selenka described, which should be of such shape as to admit of removing the hardened paraffin readily, and at the same time with depressions of sufficient size for any but very minute objects, Mr. Andrews made use of the following simple device, which, though more clumsy than the tube of Selenka, can be used for objects 1 mm. long and much larger, while giving a block of paraffin of very regular shape and with rectangular sides.

A common flat medicine bottle is fitted with a cork through which two tubes pass, or, if the mouth is small, one tube may be fastened into a hole drilled into the bottle. One of these tubes A is connected with hot and cold water; the other B is a discharge-pipe for the water entering the bottle by A, and raising or lowering its temperature as warm or cold water is allowed to flow in. On the smooth flat side of the bottle four pieces of glass rods or strips are cemented fast, so as to inclose a rectangular space C, which forms a receptacle for the melted paraffin. As long as the warm water circulates through the bottle the paraffin remains fluid, and objects in it may be arranged under the Microscope by light from above or below, and can be oriented with reference to the sides of the paraffin-receptacle or with reference to lines drawn upon the surface of the bottle. When the cold water is allowed to enter in place of the warm, the paraffin congeals rapidly, and may be easily removed as one piece. The discharge-pipe should open near the upper surface of the bottle, to draw off any air which may accumulate there.

Orienting Small Objects.‡—It is frequently a very difficult matter to properly orient small objects, especially spherical eggs, so that sections may pass through any desired plane. In working on the embryology of the common shrimp, Mr. J. S. Kingsley found the following process very convenient:—Impregnation with paraffin is accomplished in the usual way, and then the eggs (in numbers) in melted paraffin are placed in a shallow watch-crystal. They immediately sink to the bottom, and then the whole is allowed to cool. The crystal, glass upwards, is now placed on the stage, and the eggs examined under a lens. In this way one can readily see exactly how any egg lies, and then with a knife it may be cut out with the surrounding paraffin, and in such a way that it can readily be fastened to the block in any desired position. After all which have been dropped in a

* Amer. Naturalist, xxi. (1887) pp. 101–2. † See this Journal, 1885, p. 1086.
‡ Ibid., p. 102.

suitable position are thus cut out, the paraffin is again melted, and after stirring the eggs the cutting out is continued as before.

Method for Reconstructing Small Microscopic Objects.*—Dr. N. Kastschenko's method depends on the principle of obtaining two intersecting and perfectly smooth surfaces which he terms definition planes. In respect to the reconstruction of the object, he follows previous methods, especially that of His. He imbeds his object in paraffin and stains the surface of the block with lampblack dissolved in about ten times its bulk of turpentine. The stained block *a* is in its turn imbedded in paraffin (fig. 150). The accuracy of the surfaces is obtained by means of the machine (fig. 151)

FIG. 150.

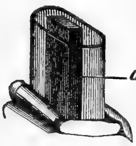
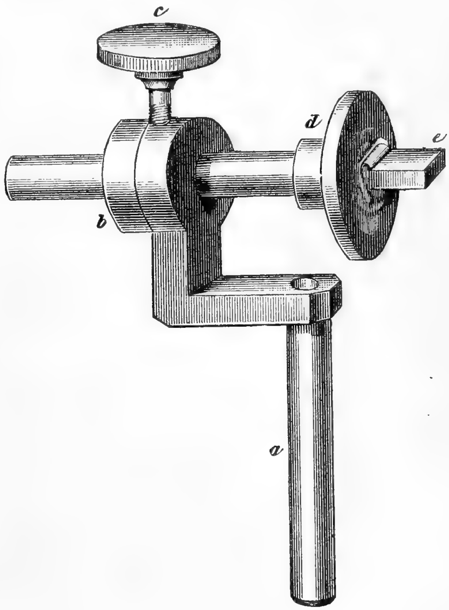


FIG. 151.



invented by the author, and intended to be adjusted to the Schanze microtome. It consists of a bar *a* bent twice at a right angle: through the ring *b* at its upper end runs a bar, terminated by a circular disc *d*, to which the preparation *e* is attached: the horizontal bar is fixed in the desired position by the screw *c*.

The construction of the object is effected in the usual manner, and is divisible into two chief groups, surface construction and serial construction. For the former, transparent material, such as glass, wax-paper, are employed to obtain a figure from the superimposed sections. Under some circumstances the camera lucida may be used to draw successive sections on the same paper. For surface construction, longitudinal sections are the most suitable.

In serial construction the reproduction of the object is easily obtained by the aid of the definition lines, which are made in every drawing of a section in the same position as far as regards the *definition surface*, but which will of course vary in reference to the parts of the object (cf. figs. 152 and 153, *e f*, *g h*). Axial revolution of the object renders reconstruction more complicated; in this case it is unavoidably necessary to draw a circle with the same radius in each section, so that its position in relation to the definition surfaces shall remain the same for every drawing (figs. 152 and 153). Hence the position of the various organs of the object which lie in a

* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1886, pp. 388–94 (1 pl.).

definite plane is projected upon the corresponding diameter of the described circle.

The employment of definition surfaces renders possible not only accurate reconstruction but also determines the change of form of the whole

FIG. 152.

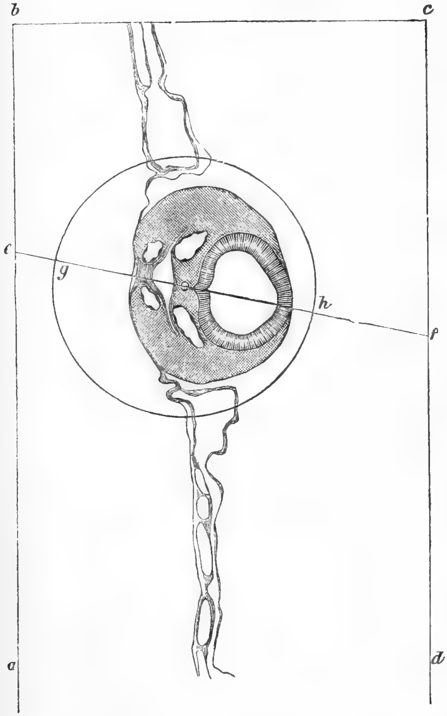
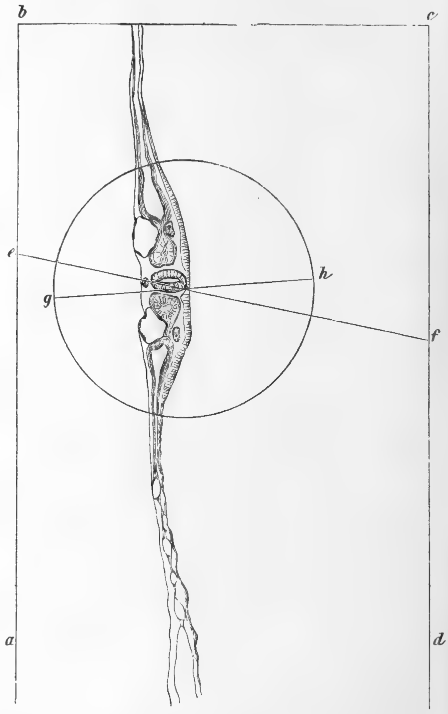


FIG. 153.



object, the position of its various parts in the successive sections, and even allows the size of the angle about which the object has turned to be calculated.

REEVES, J. E.—**How to work with the Bausch and Lomb Optical Co.'s Microtome, and a method of demonstrating the Tubercle Bacillus.**

27 pp., 8vo, Rochester, N.Y., 1886.

(4) Staining and Injecting.

Absorption of Anilin Pigments by living Vegetable Cells.*—Dr. W. Pfeffer continues his researches on this subject, using for his experiments solutions of one part in a million of the pigment, and in the case of methyl-violet, one part in ten millions. If the pigment which enters the cell remains unchanged, the concentration must remain the same inside and outside the cell, and no staining could be detected under the Microscope. Any tinging of any part of the cell must be due to a chemical change in the pigment;

* Unters. Bot. Inst. Tübingen, ii. (1886) pp. 179–331. Cf. this Journal, *ante*, p. 172.

and if the new compound is also coloured, and either not or only slightly diosmotic, a perceptible accumulation of pigment takes place in the cell. The absorption and storing up of the anilin pigments is not connected with the vital activity of the cell. The following are absorbed by the living cell, viz. methyl-blue, methyl-violet, cyanin, Bismarck-brown, fuchsin, saffranin, methyl-orange, tropæolin, methyl-green, iodine-green, Hoffmann's violet, gentian-violet, rosolic acid. No special staining of the cell-nucleus or chromatophores was observed in any case, but a tinging of the protoplasm with all except methyl-blue, and an accumulation in the cell-sap with all except rosolic acid; the microsomes, granules, and vacuoles were also stained. No absorption appeared to take place of nigrosin, anilin-blue, marine blue, anilin-grey, eosin, or Congo-red.

In a subsequent communication,* Dr. Pfeffer states that methyl-blue is largely absorbed by the living cell, a definite chemical compound with tannic acid being formed. The pigment subsequently either remains in the cell or passes out into the surrounding water. This exosmose can also be brought about by the action of citric acid. He suggests that these phenomena may illustrate the analogous phenomena exhibited by the food-materials of plants.

Modification of Weigert's Method of Staining Tissues of the Central Nervous System.†—Dr. N. M. Gray hardens specimens in Müller's or Erlicki's fluids, and then transfers directly to 70 per cent. spirit, and afterwards to absolute alcohol for several days. They are then soaked for one or two days in a mixture of equal parts of ether and absolute alcohol, and next transferred to a solution of celloidin, and eventually imbedded in celloidin on cork. The pieces, still fastened to the cork in the celloidin, are immersed in a solution of neutral acetate of copper (a saturated filtered solution of this salt diluted with an equal volume of water), and allowed to remain in an incubator at 30° or 40° C. for one or two days. The specimens become pea-green after the copper treatment, and the celloidin of a blueish-green. They may now be preserved in 80 per cent. spirit indefinitely. After having made sections, which must still be kept clear of water, they are immersed in the hæmatoxylin solution, the formula for which is as follows:—Hæmatoxylin (Merck's, in crystals) 1 part, absolute alcohol 10 parts, water 90 parts. Boil twenty minutes, cool and filter, and to each 100 parts add 1 part of a cold saturated solution of lithium carbonate. The time for staining varies; in general, the larger, the sooner the result: for cord sections 2–3 hours are enough; for brain sections twenty-four hours are required to colour the very fine fibres of the cortex.

After staining, the sections, now black, are decolorized by immersion in the following fluid:—Borax 2 parts, ferricyanide of potassium $2\frac{1}{2}$ parts, water 100 parts. For cord, half to several hours; for brain sections longer.

From this solution, the sections are transferred to water and well washed, then to 80 per cent. spirit, then absolute alcohol, then cleared up in xylol or creosote, and mounted in xylol- or benzole-balsam.

Modification of Golgi's Method for Staining the Central Nervous System.‡—Signor Tal modifies Golgi's method as follows:—The small pieces of the central nervous system previously prepared by Golgi's method (hardening in bichromate of potash, and subsequent treatment with a 1/2 per

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen. Versamml., p. xxx.
† Amer. Mon. Micr. Journ., viii. (1887) pp. 31–2, from Med. News, 1886.
‡ Gazz. Ospit., vii. (1886) No. 68.

cent. of corrosive sublimate), are placed in a solution of sulphide of soda. The mercury, already reduced from the sublimate, is changed into sulphide, and the preparations become blackened. The tissue, which has not undergone the influence of the foregoing reaction, is stained with a solution of Magdala red, which gives extremely beautiful pictures. Even Golgi's nitrate of silver method is improved by after-treatment with sulphide of soda.

China-Blue as a Stain for the Funnel-shaped Fibrils in Medullated Nerves.*—Signor C. Galli has succeeded in staining with China-blue the spiral or funnel-shaped fibres of the myeline sheath of peripheral nerves, about the existence of which there was once considerable dispute.

The procedure, which is very simple, is as follows:—The sciatic nerve, carefully cut out from a recently killed animal, is placed in Müller's fluid for eighteen to twenty days. It is then cut up into pieces 5 or 6 mm. long, and these pieces are placed for one or two days in a mixture of one part Müller and two parts water. They are then cut up lengthwise, and immersed in a few drops of glycerin to which glacial acetic acid has been added in the proportion of one or two drops of acid to 1 or 2 c.cm. of glycerin. In this they remain for fifteen to twenty minutes, according to the greater or less acidity of the glycerin. The pieces are then placed in ordinary spirit, where they lose the excess of their colour, and are then coarsely teased out. They are next dehydrated in absolute alcohol, and then cleared up in oil of turpentine. Lastly, a small piece is carefully teased out on a slide and then mounted in dammar.

From the author's description, it would seem that the staining is somewhat diffuse, so that sometimes the funnel-fibres are obscured by the darker stain of the other constituents of the nerve, especially the sheath of Schwann. The blue stain colours the axis-cylinder, the myeline sheath of Schwann's membrane, as well as the funnel-fibres and the primitive sheath nuclei. From the illustrations given by the author, we gather that the axis-cylinder and the nuclei are the less colourable parts.

New Staining Method for Sections.†—Dr. H. Kühne thinks that it is advantageous to pass sections through a concentrated watery solution of oxalic acid and then thoroughly wash them before staining. For this purpose the author uses watery solutions of the dyes which in the case of fuchsin he combines with anilin or thymol water; of methylene blue with a 1 per cent. watery solution of ammonia carbonate; of violet with anilin or thymol + ammonia carbonate. Differentiation is not effected with acids and alcohol, but the sections are first dehydrated in absolute alcohol, to which some of the first used dye has been added.

Differentiation is attained by means of acid stains, of which fluorescin is the most universally applicable. This is dissolved in oil of cloves, and from the mixture the sections are passed through turpentine to xylol and then to xylol balsam.

Double Staining with Orcin.‡—Dr. O. Israel has introduced a new dye, orcin ($C_4H_7NO_6$), to microscopical and especially to bacteriological technique, being suitable for most bacteria as well as for various tissues. It is a vegetable dye which unites in itself the staining properties of the basic and acid stains, and also the combination of two contrast colours.

If sections of actinomycotic tissue be placed in a saturated acetic acid solution, the fungus assumes a dark Bordeaux-red hue, which is the more

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 465–70 (1 pl.).
† Zeitschr. f. Hygiene, i. (1887) p. 553.
‡ Virchow's Arch. f. Path. Anat. u. Physiol., cv. (1886) p. 169.

pronounced if the surrounding tissue be quite decolorized with alcohol. If, however, decoloration be not carried so far, it will be found that in addition to the fungus, the nuclei of the surrounding tissue are blue and the protoplasm red. As glycerin extracts the blue colour, preparations must be mounted in balsam.

As dehydration conducted in the ordinary manner would deprive the sections of colour, it is necessary, after having washed in distilled water, to pass rapidly through absolute alcohol to the slide, where the excess of spirit is to be quickly blotted up. A drop of thick cedar-oil is then added, and as this soon hardens, balsam need not be applied. Thus prepared, specimens have kept well for five years.

Double Staining with Echein-green and Carmine.*—Mr. J. D. Beck states that he has met with splendid results by a combination of echein-green (an acid dye) and carmine. He first stains the sections with the echein-green for five seconds to ten minutes. They are then washed in distilled water from 150° to 212° Fahr. for two to twenty minutes. If time allows, cold water acting for a longer time acts as well. Alcohol first of 60 and then of 95 per cent. hastens the process. The object of the foregoing is to remove all acidity before staining with carmine. The sections are tested for acidity by allowing some water from the slide on which a section is placed to drop on the tongue, or to add some carmine to the slide water and examine under the Microscope to see if any precipitate occurs when ammonia carmine is added. If all traces of acidity be removed, the carmine staining may be proceeded with.

When sections have a feeble affinity for green, the author mounts in the following medium:—White sugar syrup 1 oz., pure glycerin 10 to 30 drops; mix thoroughly. When stained the section is first cleared in pure glycerin, the surplus of which is washed off with water; the latter is evaporated and then the syrup added.

Stained Permanent Preparations of Cover-glass Cultivations.†—Dr. F. Lipeż's method for preparing and staining cover-glass preparations suitable for observing under high powers the developmental changes in micro-organisms, consists in first obtaining a thin layer of the nutritive medium previously inoculated to any desired degree with the micro-organism to be examined. The medium is kept in a water-bath at a temperature of 25° or 40° C., according as gelatin or agar is used. With this the surface of the cover-glass is moistened and the superfluous matter drained off with blotting-paper. A film about 0·08 mm. thick is thus obtained. The covers are then placed in a moist chamber or in an incubator, and are then withdrawn at definite intervals. They are dried (best over strong sulphuric acid), stained, decolorized, and mounted in balsam.

The most difficult part of the operation is to decolorize the gelatin or agar without removing the stain from the organisms. The behaviour of the various dyes and of the nutrient layers is very different, but the author mentions, provisionally, that methyl-green is easily removed, and that alcohol and carbonate of potash may in a measure be relied on for decolorizing. Again, some care is necessary to prevent the "fluidifying" bacteria from being washed away, while of other varieties many stick firmly to the cover even after the medium has been removed.

New Methods of using Anilin Dyes for staining Bacteria.‡—Mr. E. H. Hankin premises that in the methods he describes care must be given

* The Microscope, vii. (1887) pp. 69–71.
† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 402–3.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 401–11.

to the hardening of the sections; Müller's fluid must always be used, and the tissues cut into very small pieces.

For the first method the materials required are (1) a strong watery solution of methyl-blue or Weigert's anilin oil solution, (2) a saturated alcoholic solution of eosin, (3) a pipette, (4) absolute alcohol kept as free as possible from water, (5) benzine and clove-oil in equal parts, with an addition of absolute alcohol, sufficient to dissolve the turbidity which appears on shaking these reagents together, (6) fresh and nearly colourless oil of cloves, (7) benzine, xylol, or cedar-oil. The sections, on being taken from spirit, are placed in the methyl-blue solution, and eosin is immediately dropped in from the pipette—about equal parts should be used. The sections should be at once removed to absolute alcohol, and, after a few seconds' shaking, placed in the benzine and clove-oil mixture; as soon as the effects of the eosin begin to be apparent, they should be placed in benzine and mounted. The whole process does not take more than a minute. Sections thus stained show the bacteria and the nuclei blue, the eosin stains the red blood-corpuscles orange, and the background of the tissue is of a rose-red tint.

Successful results were also obtained with watery solutions of Spiller's purple; as soon as the sections are placed in it an equal bulk of alcoholic Spiller's purple must be dropped in from a pipette; the sections are then dehydrated in absolute alcohol as quickly as possible, and removed to the benzine and clove-oil mixture. When cleared, the sections are placed in eosin dissolved in oil of cloves, which stains the background red, and turns out the excess of Spiller's purple; the sections are then washed in oil of cloves, passed through the benzine and clove-oil mixture, placed in benzine and mounted. A somewhat similar method was adopted with fuchsin or gentian-violet as the staining reagent.

In all these methods, advantage is taken of the well-known fact that benzine does not dissolve, and therefore fixes the anilin dyes; one of the advantages of placing sections in benzine before mounting is that any residue of clove-oil is removed. Some of the methods used give results which promise to be very permanent.

Staining Cover-glass Preparations of Tubercle Bacilli.* — Dr. H. L. Tohnan obtains very satisfactory results by the following modification of the Weigert-Ehrlich method.

(1) Anilin oil 30 drops, distilled water 3 oz. Shake vigorously for five minutes and filter.

(2) Saturated solution of fuchsin in 93 per cent. alcohol. Mix together in a watch-glass 2 dr. of No. i. and 15 drops of No. 2. Upon this drop the cover-glass, whereon the sputum has been applied in the usual manner, and allow to stain for twelve hours. Decolorize in 33 per cent. nitric acid until the colour has *almost* gone. By the use of heat the staining may be effected in from 30–60 minutes; but in this case the acid solution is not stronger than from 5 to 15 per cent.

The author recommends the following for preserving, and at the same time staining sputum. The patient puts the sputum first coughed up in the morning into a mixture of anilin oil solution, as above, 2 dr.; fuchsin stain 20 drops, carbolic acid 10 per cent. solution 5 drops.

This mixture is to be prepared fresh, and the sputum left therein for at least twenty-four hours.

This method, as far as time goes, is not to be compared to the Neelsen-

* The Microscope, vii. (1887) pp. 83–4, from 'Medical Record.'

Glorieux method described in this Journal, 1886, p. 537. The latter operation only takes five minutes altogether.

Staining of Syphilis and Tubercle Bacilli.*—Dr. B. Bienstock relying on the assumption that smegma bacilli owe their resistance to decoloration to a coating of fatty matter, bred various kinds of bacilli (of fæces, of green pus, of anthrax, and of typhoid bacillus) in butter-gelatin. According to his expectation, he found that the bacilli thus cultivated show the same resistance to acids as do those of syphilis and tubercle. The material employed was 100 grm. of agar-gelatin mixed with about 20 grm. of boiled butter. The mass having been sterilized is placed in test-tubes and frequently shaken up and the test-tubes put in an oblique position, in order that only a small drop of butter may find its way to the top of the gelatin when it sets. The bacilli grown in the butter-layer were found to possess the staining property alluded to, but not those found in the layers below or above.

The author explains these facts by supposing that the fat-envelope permits the passage of colouring matter but resists the penetration of any decolorizing watery fluid. The staining of tubercle is, according to the author, due to a mantle of fat derived from the necrosed tissues or from the blood-serum; and if this be the cause the diagnostic value of the Ehrlich stain is lowered and ceases to be a characteristic of tubercle bacilli.

Staining Syphilis Bacilli.†—After the ordinary fixative in the flame and staining with fuchsin, Dr. De Giacomi washes the cover-glass with water in which a few drops of iron chloride are dissolved, and then decolorizes in concentrated iron chloride. The bacilli appear red; no other bacilli are stained. The preparation may be contrast-stained if desired.

Staining Micro-organisms in the tissues of children affected with hereditary Syphilis.‡—Drs. M. Kassowitz and C. Hochsinger have found, especially in the blood-vessels of the affected organs, collections of chain-cocci. The authors employed Gram's method. For permanent preparations it was found advisable either to leave the sections in the gentian-violet solution for 12 to 24 hours, or to use a concentrated solution (30 parts alcoholic gentian-violet solution to 70 parts anilin water). Acids completely decolorized the bacteria. Double staining was effected by means of picro-carmine, the solution being afterwards washed in a 1 per cent. hydrochloric acid alcohol, and then neutralized in a half per cent. solution of potash. By the foregoing method the bacteria appear dark blue, and the rest of the tissue a brightish red.

Staining of Lepra Bacilli.§—The well-known rapid disappearance of the stain from lepra bacilli induced Dr. P. G. Unna to ascertain the reason for this phenomenon, in order to be able to meet it by proper rules. The original supposition that the decoloration of the permanent preparations in question depends on an oxidation of the resins and ethereal oils used for clearing up and for mounting, was not confirmed: it rather turned out that if, as there is no doubt from Dr. Unna's experiments, an oxidizing action comes into play in the decolorizing of balsam preparations, this at any rate is to be regarded only as a reduction of the anilin colours. In order to trustworthily demonstrate the affinity for oxygen of the ordinary (i. e. in use) clarifying and mounting materials, Dr. Unna recommends the

* Fortschr. d. Med., iv. (1886) p. 193.
† Correspbl. d. Schweizer Aerzte, 1885, No. 12.
‡ Wiener Med. Blätter, 1886, Nos. 1–3.
§ Monatschr. f. Prakt. Dermatol., Ergänzungsh. 1885, p. 47. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 557–9.

following method, communicated to him by Dr. H. Hager. The fluid or its solution in absolute alcohol or benzol is treated with a few drops of mercury nitrate. If the body have any affinity for oxygen a grey metallic deposit is thrown down.

The results which Dr. Unna obtained with this test agree with the long known experience that oil of cloves and oil of turpentine are inimical to the anilin stains; for while, on the one hand, cedar oil as a clarifying agent and the hydrocarbons of the benzol-xylol series as solvents of the resins are superior to the former; yet on the other hand they show that the affinity for oxygen is detrimental to the anilin stains, for glycerin and carbolic acid, which, as is well known, quickly and permanently extract all basic anilin dyes, do not possess according to Hager's test, any reducing power. Together with the influence of oxygen there had been associated as a matter of course the acid nature of the resins which were charged with the decoloration of the preparations. Closer examination of the conditions showed that the acid reaction in itself did not so much represent the baneful factor, as rather the circumstance that the acids entered into new and unstainable combinations with the basic anilin dyes which were fixed in the tissues. In order to obviate as far as possible the latter contingency, the resins must be freed from all traces of ethereal oils by prolonged boiling and thickened to such a degree that they set immediately when applied to the preparation. But the deoxidation and the action of acids are not the only influences which make themselves felt; the remains of the acids (HNO_3HCl, acetic acid) used for the decoloration of sections are probably more dangerous than all the resin acids. Therefore for the removal of these residua the greatest care is required, for though we may avoid, as far as possible, all the mentioned sources of decoloration, there yet clings to the oil and balsam method the inconvenience of over-removal of the stain owing to the use of alcohol unavoidably necessary for dehydration.

Dr. Unna has now contrived a method which renders unnecessary not only the use of alcohol, but also the ethereal oils as clarifying media, preparatory to mounting in balsam—the so-called dry method. Here the stained sections, after decoloration by acid, and after staining with a second dye, are taken directly from water to be placed on the slide, and having next been carefully spread out and freed from superfluous water by pressing them with tissue paper, are heated slowly and carefully over a spirit-lamp to dryness. Upon the dried section and (if possible) warmed slide is poured a drop of the balsam selected. With regard to the permanence of the bacillar stain, the dry method, as far as can be gathered from Dr. Unna's comparative preparations, is not more efficacious than the oil method when carried out with the precautions insisted on by him. Yet the former, according to Dr. Unna's researches, which he reports in another treatise immediately following the one under discussion, and the contents of which cannot here be examined, should have, apart from their simplicity, the economy of material, time, and trouble, a noteworthy advantage for the recognition of micro-organisms and their relations to the tissues.

In a retrospect on the results thus obtained Dr. Unna gives detailed directions for carrying out both the dry and the oil methods, as modified according to the principles of the above-mentioned precautionary measures.

Solution of Hypochlorite of Soda with excess of chlorine as a Decolorizer.*—This solution is prepared by dissolving 8 parts of caustic

* Journ. de Micrographie, xi. (1887) pp. 154–5.

soda to 100 parts of distilled water, and passing chlorine through to saturation. The action is indicated by the following formula:—

$$2NaHO + 2Cl = H^2O + NaCl + NaClO.$$

The solution thus contains 7·45 per cent. of hypochlorite of soda. During the passage of the chlorine it is necessary to surround the solution with a mixture of salt and pounded ice, otherwise the temperature rises, and chloride and chlorate of soda are produced. The more effectual the cold, the greener is the colour of the fluid, but the greenness fades away by exposure to light and with lapse of time. The decolorizing action is proportional to the greenness of the solution, and is due to the presence of chlorine, and also to the hypochlorite of soda, which bodies act in virtue of their property of setting free nascent oxygen.

Experiments made with the foregoing solution by Prof. C. V. Ciaccio and Dr. G. Campari, on animal and vegetable tissues, have demonstrated its perfect efficacy, not only with the colouring matter of leaves and plants, but also with the pigment in the retina, in the chitinous investment of insects, and in melanotic morbid products. Hitherto these last three examples have been held to be unalterable. Specimens to be decolorized must first of all be hardened in alcohol and chromic acid or its salts.

LATHAM, V. A.—**The Microscope and how to use it.** X. [Injecting—*contd.*]
Journ. of Microscopy, VI. (1887) pp. 102–11 (1 fig. and 1 pl.).

UNNA, P. G.—**Die Rosaniline und Pararosaniline. Eine bakteriologische Farbenstudie.** (Rosanilin and Pararosanilin. A bacteriological staining study.)
73 pp., 8vo, Hamburg, 1887.

(5) Mounting, including Slides, Preservative Fluids, &c.

Medium for clearing up Celloidin Sections.*—Dr. C. Weigert finds that a mixture of xylol and carbolic acid is efficacious for clearing celloidin sections stained with hæmatoxylin or carmine.

Three parts by volume of xylol are mixed with one part pure carbolic acid; and in order to be sure that water is absent from the mixture recently burnt, sulphate of copper is added. The copper sulphate is placed at the bottom of a 250 gram bottle, so as to form a layer about two cm. high. The mixture is passed over it, and the two are shaken up together. After standing, the clear fluid is decanted off.

This mixture is found to clear riband sections taken from 80 per cent. alcohol. It can only be used for carmine and logwood stained preparations, for basic anilin dyes are decolorized or removed from the sections by it. But for bacterial investigations, if the preparation be first stained with carmine, Gram's method, as used by Weigert, can be adopted, provided that anilin oil be substituted for the carbolic acid in the clarifying medium. The last method is, however, said to need improvement.

Reagents for clearing Celloidin Sections for Balsam Mounting.†—Dr. J. van Gieson finds that the only satisfactory reagent for clearing sections imbedded in celloidin is Ol. Origani Cretici, or Spanish hopfenœl. This clears rapidly, even in moist weather, after dehydration in 95 per cent. alcohol. It is free from acid, and does not fade the Weigert hæmatoxylin stain if the preparations have been hardened for a long time in Müller, and are mounted in thick balsam. It is also good for Gram's method, the

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 480–81.
† Amer. Mon. Micr. Journ., viii. (1887) pp. 49–51.

simple anilins, logwood, and eosin. When fresh it is of a light amber colour, and does not clear readily, but after having been exposed to the air it becomes darker, and its action more rapid.

The author finds that oil of thyme causes the Weigert hæmatoxylin stain to fade, and that its clarifying property is weak, requiring very thorough dehydration, and that it corrugates the celloidin. An unfavourable opinion is expressed as to the value of Minot and Dunham's clarifier, viz. the mixture of oil of thymol and oil of cloves. Anilin oil clears rapidly, and leaves the celloidin quite pliable, but unless thoroughly (almost an impossibility) removed, the preparation becomes yellowish-brown. Xylol requires very thorough dehydration, and corrugates the celloidin. Bergamot clears well, but damages the stain, especially eosin. Creosote is of very variable composition; some kinds dissolve celloidin. M. Flesch recommends beechwood creosote.

Mounting Sections prepared by Golgi's Method.* — Signor Magini, in order to render permanent preparations obtained by Golgi's method, recommends that the sections when taken from the bichloride of mercury, should be placed in a mixture of equal parts of absolute alcohol, and wetted and shaken up. They are then immersed in creosote for about half an hour, and when on the slide, the creosote is carefully removed with blotting-paper, and the preparations mounted in dammar dissolved in chloroform and ether.

Rapid Method of Dry Mounting.†—Mr. A. W. Stokes takes a mixture of equal parts of paraffin wax and bees'-wax; a piece the size of a pea is placed on a glass or metal slip. This is heated till it melts and forms a thin film; in contact with this are placed the rings intended to form the cells. First one side, then the other side of the rings is brought in contact with the melted wax. The rings are taken off, and in a second or two are cold and hard. One of these is placed on a clean glass slip in the position desired, and heat applied below the slip till the waxed surface of the ring melts and adheres. It is now allowed to cool. The object meanwhile is dried in a desiccator over sulphuric acid or calcic chloride; it is then placed in the cell and fastened in position by a minute fragment of wax. Gum will not do for fixing the object, since if really dry it will not adhere at all. A cover-glass is now taken, one side cleaned and heated; while still hot it is placed on the top of the cell. This top surface having already, as described, been covered with wax, the glass at once adheres, and the object is dry-mounted permanently. There is no liquid to sweat, and no time wasted in waiting for the cell to dry. So strongly does the mixture of waxes adhere, that it is not easy, without applying heat, to detach either cell or cover-glass. Cells can be made out of tissue paper, if required very shallow, or any of the ordinary rings may be used. Vulcanite cells, expanding and contracting very nearly the same as glass with differences of temperature, are preferable. Of course, the cells may be finished off afterwards with any of the usual cements.

The method does not require any turntable, brushes, or other of the usual apparatus; it is claimed to be inexpensive, rapid, effectual, and permanent.

Experiments with Media of High Refractive Index.‡—Mr. W. Morris has made a large number of experiments on mounting media of high refractive index, the object used being *Amphipleura pellucida.* The paper

* Boll. R. Acc. Med. Roma, xi. (1885) No. 7. † Eng. Mech., xliv. (1887) p. 148.
‡ Journ. and Proc. R. Soc. N. S. Wales, xix. (1886) pp. 121–33.

cannot be fully summarized here, and the original must be referred to by those desiring to know the results obtained with the various media.

Success was obtained with sulphur by special manipulation; also with piperine, the alkaloid of pepper, and with "biniodide of mercury, solid," which consists of a saturated solution of the biniodide in piperine. The alkaloids of opium, with few exceptions, are all high-class media; and of the alkaloids generally, the author says "for bacteria mounting, quick work, and splendid definition, giving immensity of light even to the F eye-piece, I am certain they cannot be surpassed, the bacteria being shown like beads of coral when stained with a red dye." Good results were also obtained by holding the prepared cover-glass over the mouth of a vial containing chloro-chromic acid, a highly volatile liquid giving off red fumes when exposed to the air.

Numerous chlorides and iodides were experimented with, of which we select the following:—

Chloride of tin is used thus:—"On placing a small portion on the mica slip and subjecting it to heat, dense fumes mixed with the water of crystallization are given off; and when only a clear liquid is left behind, still giving off white fumes. The cover-glass is held in position with a pair of forceps to intercept the fumes, a white deposit is immediately formed, and the moment a sufficient quantity is deposited, the cover-glass is withdrawn and held over the heated mica until resublimation takes place, leaving a metallic 'scud' on the cover-glass. When mounted in piperine, if properly managed, the diatoms will be found lying in a film of chloride of tin, the striæ beautifully defined, of a steel-grey lustre, and around the edge of the valve a golden-yellow tinge. The author thinks the definition quite up to the phosphorus mounts. Being a deliquescent salt, it must be mounted when hot, if not, moisture will be again absorbed, and the slide will be found to be worthless when mounted."

Iodide of arsenic gives splendid definition to the striæ, and is also of value for mounting bacteria.

Iodide and bromide of silver, with a little manipulation, will rival any of the phosphorus and silver mounts.

Of chloride of tellurium, the author writes, "This preparation, manipulated in the same way as the chloride of tin, is the best medium for showing the *A. pellucida* that I have experimented with. The richness of the colouring is something grand to look at. The beautiful steel-grey striæ, bold and well-defined, with the golden-yellow tinged edge of the valve, makes this the most showy slide that can possibly be exhibited, and in my opinion surpasses Professor Smith's American slide, the medium of which has a refractive index of 2·4."

Of chloride of thallium, he says, "This is a very fine medium; instead of the steel-grey a sea-green colour is given to the striæ; with the golden-yellow tinged edge to the valve, it makes a very pretty exhibit. It has a propensity of causing the piperine to crystallize; this can be got over by using the valerianate of quinine as a substitute for the piperine. I do not think this impairs the resolution, whilst it still keeps up the chromatic appearance. Some of the valves are resolved as well as with the tellurium, others again have got a varnished look, as if the interspaces between the striæ were filled up, and after careful examination minute cracks may be seen in the thin film covering the diatom, as if the thallium had infiltrated itself between the cover-glass and diatom. Those valves found in this state are not so well resolved, giving a more faint look to the striæ."

By mixing chloride of thallium and chloride of tin together, and sub-

liming as usual, the difficulty of crystallization with the piperine is got over, and also the varnished appearance to the diatom, giving a resolution better than any previous medium. The valves may be seen with the central rib jet-black, striæ a greenish steel-grey, hard and crisp, the outer edge either black or yellow tinged, according to the amount of film the diatom is lying in.

The author, who discards ringing, states that he is "prepared to mount, clean, label, and resolve the *A. pellucida* under five minutes' time, in one of the high refractive media, and in no part of the world can the same feat be performed at the present time, so far as our micro information is to hand to date" (November 1885).

New preparation of the medium of high index (2·4) and note on Liquidambar.*—Dr. H. L. Smith's yellow medium consists, as previously noted, of realgar dissolved in bromide of arsenic. It is not, however, the product known in commerce as realgar, that is a brownish-yellow opaque substance with a vitreous fracture, but the realgar of mineralogists, of a beautiful reddish-yellow colour and perfectly transparent. When Dr. Smith published the formula of his medium, the realgar was produced by melting two parts of sulphur with one part of metallic arsenic and keeping the fused mass at a red heat for several hours. After several attempts at making realgar, Dr. H. van Heurck found that it could be more easily and satisfactorily produced by melting together one part of sulphur and 1·7 part arsenious acid in a retort, and raising the temperature to distillation point. Realgar thus obtained by distillation quite resembles the mineral variety. It is then dissolved, by heat in a test-tube, in tribromate of arsenic, also obtained by distillation. The product is a syrupy liquid of a greenish-yellow colour, almost black in large quantity.

The diatoms being fixed to the cover-glass by desiccation, are covered with a drop of the liquid medium. The cover-glass is then placed on the slide, and the latter strongly heated in the flame of a spirit-lamp. Large bubbles are given off and the medium assumes a deep red hue, while at the same time the bromide of arsenic volatilizes. When the ebullition and the volatilization are nearly ended, the heating is ceased, slight pressure is applied to the slide, and it is then allowed to cool slowly. As it cools the medium loses its red colour and finally becomes of a pale yellow hue. During the manipulation, which is not difficult in itself, care must be taken to avoid the dangerous vapours.

Prepared in the manner indicated above, the medium has two disadvantages, first, the liquid alters very quickly, and can only be preserved in tubes hermetically sealed, secondly two-thirds of the preparations are spoilt, often very rapidly, and without any apparent cause. In order to remedy these defects, Dr. H. van Heurck made in the past two years numerous experiments, and at last found a method of preparing a solid substance which can be preserved without undergoing change in the air; and the preparations mounted therein have hitherto kept most perfectly. The author prepares his medium by dissolving in a glass vessel 30 parts by weight of flowers of sulphur in 10 parts of bromine, and thus obtains a solution of sulphur in the bromide of sulphur (S_2Br_2). After perfect combination, 13 parts of metallic arsenic in impalpable powder are added, and the mass heated until the arsenic is perfectly dissolved. The mass is then poured into a porcelain dish and heated over an open fire and constantly stirred with a glass rod until it is found that a small drop is very brittle when cool. The medium is then poured into a cold plate, and when

* Bull. Soc. Belg. de Micr., xiii. (1886–7) pp. 20–4.

quite cold the mass is divided into pieces and preserved in a stoppered bottle. This glassy mass, of a greenish-yellow colour, is what the author calls the first degree, and its index of refraction is = 2·1203 or 2·12 according to calculations made by the firm of M. Zeiss.

On heating for a longer time the mass thickens and the index = 2·2534 or 2·25. During the preparation of the object a part of the sulphur volatilizes and when properly heated the index may be 2·4. The two products may be used indifferently but both, especially the second, are difficult to melt. If so desired they may be dissolved at the time of using in a little bromide of arsenic, but then the same inconveniences may arise as from Smith's original medium.

Liquidambar prepared according to the author's formula is obtainable from M. P. Rousseau of Paris. Samples of the liquidambar show that the mass is hard enough to fix the cover-glass without the aid of cement. It is used either in its firm condition or previously dissolved in a mixture of alcohol and chloroform. Liquidambar, like storax, is unalterable with age; it allows structural details invisible in balsam to be clearly seen, and it may be used for histological objects as well as for diatoms. Bacteria mounted in storax or liquidambar show infinitely better than in Canada-balsam.

Fixing Sections.*—Mr. H. E. Summers writes that the method of fixing sections to the slide, as recently given by him,† has been found to be needlessly complicated when used for celloidin sections. The following simpler method is recommended.

Place the sections in 95 per cent. alcohol for a minute or two, arrange on the slide, and then pour over the sections sulphuric ether *vapour*, from a bottle partly full of liquid ether. The celloidin will immediately soften and become perfectly transparent. Place the slide in 80 per cent. alcohol, or even directly into 95 per cent. if desired. The sections will be found to be firmly fixed and may then be stained, cleared, &c.

Neat method for Rimming Microscopical Preparations.‡—Dr. A. Hansen, after alluding to the difficulty experienced in rimming round the cover-glass of preparations mounted in glycerin with the usual varnishes or lacs, states that the difficulty is easily overcome if the edge of the cover-glass be first run round with glycerin jelly which mixes easily with any superfluous glycerin. When cool the jelly allows a further coat of any varnish: the neatest is dammar.

BROWN, J. F.—**Mounting Opaque Objects.**

[3 × 1 in. strips of heavy cardboard with a central hole 3/8 in. in diameter. "The object to be mounted is placed over the hole of one strip, and then a second strip is placed over the first and secured to it, thus firmly holding the object between them."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 73.

CODLING, W. E.—**Notes on Mounting. 1. Materials.**

Wesley Naturalist, 1887, pp. 81–2.

FRAZER, A.—**On a simple form of Self-centering Turntable for ringing Microscopic Specimens.**

[(1) Much larger and heavier than usual, so that slides which have the specimen mounted *not* in the middle of the slide will not project beyond the edge of the disc when being ringed; (2) the springs are made with a special form of "washer," so that these (the springs) may be turned freely in any direction; (3) the turntable is provided with a simple arrangement, consisting of three screws, which are placed in such positions upon the table that slides either

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* The Microscope, vii. (1887) p. 73.

† See this Journal, 1886, p. 544.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 482–3.

of 1 in. or $1\frac{1}{2}$ in., if placed against them, will be accurately centered; and the screws are also so arranged that when it is desired to use the turntable as a non-centering one, the screws may be depressed below the surface of the table.]
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 333–4.

JAMES, F. L.—**Microscopical Technology.** [XV. Finishing the slide.]
St. Louis Med. and Surg. Journ., LII. (1887) pp. 36–41 (2 figs.).

(6) Miscellaneous.

Behrens's Tables for Microscopists.*—Dr. W. Behrens has here collected a series of very useful tables for microscopists and others. They comprise the comparison of the metric and English scales of lengths and weights as well as of thermometer scales; various tables of specific weights, refractive indices and dispersive powers; a numerical aperture table; and tables of hardening, fixing, imbedding, clearing, staining, and other media. There are fifty-four tables in all.

Method for Exhibiting Semi-Microscopical Objects.†—Herr F. Hilgendorf, after alluding to the difficulty of studying carefully small objects in museums, remarks that the exhibition of a large number of Microscopes is frustrated by the great expense and by the clumsiness of the public. The chief difficulty which arises from the differences of vision in different individuals, namely, constant alteration of focus, can be obviated by an ingenious contrivance such as has been employed by Dr. Zenker in the microscopical aquarium. This consists in every observer correcting his focus by means of a suitably chosen lens placed before the ocular, and with this lens traversing the whole series of Microscopes, each of which has been adjusted to the same focus.

The objects should be placed in a frame, the sides of which should be made of glass, and this frame, inclosing the specimens, set up in a vertical position close to a window. A hand-lens which allows a sufficient space between the glass and the eye for the nose and hand, would be necessary for examining purposes. The side plates of the frame must of course be made of smooth, clear, and not too thick glass. It will be found that at least 100 different semi-microscopical objects can be exhibited in each frame. As these frames stand only before the lower part of the window, darkening of the room need not be feared. If it be desirable to increase the number of preparations for examination, a contrivance adopted in some museums is recommended. This is an upright column around which are fixed a certain number of glass frames in such a manner that the latter can be made to revolve round the vertical axis.

The author enumerates certain objects suitable for such exhibition cases. These, beginning with the Protozoa, are chiefly Invertebrata, but many parts of vertebrates, such as fish-scales, otoliths, sclerotic rings, feathers, hairs, &c., are suggested.

Drying and Heating Apparatus for the Histological Laboratory.‡—Herr V. Meyer has had constructed an apparatus which, though intended for chemical work, may be found useful in the histological laboratory, instead of the incubator or hot chamber. In the latter the constancy of the temperature is maintained by means of the thermo-regulator. Meyer's apparatus dispenses with such adjuncts, because the temperature

* Behrens, W., 'Tabellen zum Gebrauch bei mikroskopischen Arbeiten.' (Tables for use in Microscopical Work.) 76 pp., 8vo, Braunschweig, 1887.

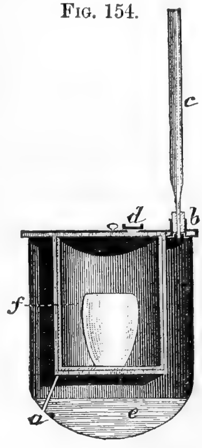
† SB. Gesell. Naturf. Freunde, 1885, pp. 13–6.

‡ Ber. Deutsch. Chem. Gesell., xviii. No. 17, p. 2999. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 74 (1 fig.).

is kept constant by employing fluids of a definite boiling-point, as regards the required amount of heat, instead of a water-bath.

A double-walled vessel (fig. 154) contains the heating fluid *e* between the two walls, the object to be heated being within the inner chamber *f*. A tubular opening *b* in the top of the vessel carries a glass condensation-tube *c* for cooling the reflux air. Air-tubes *a* enter the dry chamber from below, and the cover has an opening *d*, which is closed by a slide. The apparatus is only intended by the inventor for high temperatures, but it will undoubtedly be easy to adapt it to the wants of microscopists for the use of fluids boiling at lower temperatures. The quantity of gas used is very small, a very small jet only being required to keep the fluid boiling.

FIG. 154.



Drying Apparatus for the Laboratory.*— Herr H. Rohrbeck has devised a drying apparatus which, by taking advantage of the circulating property of hot air, and by the adoption of a chamber for heating the air previously to its admission to the drying closet, is able to preserve an equable temperature in the internal chamber.

The apparatus, apparently, consists of a double walled case, five sides of which are protected by an asbestos layer. The internal chamber is surrounded by an interspace for the circulation of the exit air, while beneath its floor is situated a preliminary heating chamber subdivided into an upper and a lower compartment. The lower compartment is heated directly from beneath by a flame. From here the heated air ascends to the upper compartment, whence it finds its way through fenestrations to the dry chamber, out of which it passes to the interspace. Thus the dry closet is surrounded by warm air. The draught can be regulated by means of valves. The apparatus is closed by a double door and is provided with the usual thermometer and regulator.

Micro-chemical Analysis of Minerals.†—Dr. T. H. Behrens gives a description of methods used for the analysis of small fragments of minerals with the aid of the Microscope, based on the detection of the various constituents by conversion into various compounds, the crystallographic forms or appearance of which are well known.

The mineral is dissolved in hydrofluoric acid, or an acidified solution of ammonium fluoride, and the fluorides converted into sulphates under such conditions that the fluosilicates and fluoaluminates only remain unaltered. Then in the concentrated solution obtained the calcium is detected in the form of sulphate, the potassium as the platinochloride, sodium as a double sulphate of cerium and sodium, lithium as sulphate after separation of the calcium sulphate, and barium and strontium also as sulphates. The double phosphate serves to indicate the presence of magnesium, and an alcoholic solution of alizarin that of aluminium. For the detection of chlorine, mercurous is preferable to silver chloride; for fluorine the best reagent is sodium chloride, the fluoride being previously converted into a silicofluoride. Test analyses are given, which were made with 0·0002 gram of tourmaline, of an apophyllite, a boracite, and other minerals.

* Chem. Ztg., 1885, No. 21. Cf. Bot. Centralbl., xxvi. (1886) pp. 313–5.
† Rec. Trav. Chim., v. (1886) pp. 1–33. See Journ. Chem. Soc. Lond.—Abstr., (1886) p. 917.

Examining Fluid-cavities in Quartz.*—Dr. A. A. Julien, after describing the selection of the material and its preparation (by grinding thin sections or chipping off thin flakes), mounting and examination, points out that the chemical nature of the liquids and gases which occupy the fluid-cavities in quartz can be detected not only by chemical means, but by the use of a few simple microscopical accessories.

The expansion of the carbon dioxide by a slight increase of temperature above 20° C. is so great that advantage can be taken of its peculiar sensitiveness in this respect for its identification, on this minute scale, by very simple means. The simplest of all is a piece of rubber tubing, about 1 ft. long and 1/8 in. in bore. If the peculiar limpidness and delicate outline of the liquid in a fluid-cavity should lead the observer to suspect it to be liquid carbon dioxide, he has but to put this tube to his mouth, and blow a gentle stream of warm air for a minute or two upon the slide, from either above or below the stage. The simple warmth of his breath (about 32° C.) will be sufficient to convert the liquid carbon dioxide into a gas and thus to render its identification at once complete; for that temperature allows at least one degree to spare in reaching the point in the pure substance (31° C.) at which this change of state takes place. If there happens to be a gas-bubble of large size in relation to the layer of liquid in the cavity, the increase of temperature tends at the same time to expand the gas, and to cause the liquid to evaporate into the inner space. These two actions usually so counteract each other that hardly any change is visible. At other times, an appearance of boiling is produced. But when the temperature of 29° to 31° C. is reached, in an instant the liquid layer disappears, and nothing is visible within the cavity except the blurred outlines of its walls. The precise temperature at which liquid carbon dioxide thus passes entirely into the gaseous form within the cavity is termed its "critical point." This is a condition affecting all liquids, that is, all condensed gases; at a certain fixed temperature—which varies with the gas—the liquid flies into the gaseous state when heated in an inclosed cavity the walls of which are strong enough to resist the enormous pressure so resulting. When the slide has cooled back to the critical point (about 31° C.), the inclusion suddenly resumes the visible form it possessed before, or sometimes assumes the form of two or three bubbles, or even occasionally of a cluster or of a shower of bubbles. If the original gas-bubble happens to be much smaller in volume than that of the inclosing liquid, and the slide is warmed gently in the same way, the bubble will be seen to dilate steadily, often rapidly, with a similar sudden disappearance of the liquid layer near the critical point.

In all such experiments, however, the observer must be on his guard as to the temperature of the atmosphere, and of the mineral section at the beginning of the observation. In a warmly heated room, during the winter, and on a warm day, during the summer, the critical point may have been already passed and these transformations have become completed. In these circumstances, no indications of the presence of carbon dioxide will be visible at the first observation, unless care has been taken to keep the slide under examination cool, i. e. below 30° C., which may be done by previously dipping it in cold water. The temperature of the air at midsummer (30° to 33° C.) is often sufficient alone to bring the liquid up to its critical point under the eye of the observer.

In most mineral sections the fluid contents of the cavities consist of water or some saline solution which would usually remain but little

* Journ. N. York Micr. Soc., i. (1885) pp. 129–44.

affected in form or appearance during an experiment like that just described. Occasionally, however, the bubbles in a water-cavity are excited into lively motion and repelled into the farthest side of the cavity by the sudden application of heat. In place of a rubber tube, the application of a warm wire, glass rod, or of the burning end of a cigar, a little below the slide, may be substituted to produce the same effects—or even the direct application of the warm end of one's finger to the bottom of the slide for a few minutes.

The author gives an interesting description of the cavities and their contents, and the phenomena which they present.

Identification of Alkaloids and other Crystalline Bodies by the Microscope.*—Mr. A. P. Smith considers that whilst the number of cases in which a crystalline substance can be identified by the Microscope alone is extremely limited, yet, as a test of purity, microscopical investigation has a very wide application. When we are dealing with a substance that, when pure, crystallizes in a different form from any particular solvent, it is manifest that any departure from that form would lead to the suspicion of adulteration. If we take such a substance as bark, or opium, it is quite possible to distinguish from each other the various alkaloids which it contains. Besides the form assumed by the free base, it is of importance to convert it into a salt, as there is frequently a marked departure in the form of the crystals, e. g. quinidine and quinidine sulphate, cinchonidine and cinchonidine sulphate. There may be cases in which the salt and the base possess the same crystalline form.

Some experience is necessary in selecting the most suitable solvent from which to crystallize an alkaloid, as the duration of the evaporation may have a marked effect upon the form of the crystals. In some cases evaporation may be accelerated by the aid of heat; in others, such a proceeding is fatal to success. The addition of alcohol to ether, and of water to alcohol, appears to be the best means of retarding the process when necessary.

Polarized light should be employed to view the crystals, either with or without a selenite plate. Here, again, the duration of evaporation has a marked effect, also the strength of the solution. If the substance is deposited in a thin film, it may be altogether invisible without polarized light. Thick crystals frequently produce colour without the selenite, and those that are very thick may depolarize without any coloration. This being borne in mind, no difficulty is experienced in practice, as it is easy to compare with an alkaloid of known purity crystallized under the same conditions.

Figures are given of various substances crystallized under the best conditions, with the name of the solvent and the linear magnification, together also with a list of alkaloids and a description of the forms of the crystals.

CARPENÈ, A.—**Nuovo processo d' analisi delle materie coloranti, introdotte nei vini ed altri liquidi ed in sostanze alimentari solide, fondato sul coloramento dei micro-organismi.** (New process of analysing the colouring matters introduced into wine and other liquids and in solid alimentary substances, founded on the staining of the micro-organisms.) 11 pp. and 1 pl., 8vo, Torino, 1887.

COLE, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. Nos. 8–9 (each 4 pp.).

Sec. I. Botanical Histology. No. 8. Studies in Vegetable Physiology. VIII. Defoliation (Plate 8. A fallen leaf. Virginia Creeper: *Ampelopsis hederacea.* Long. sec. through the stem and base of petiole.) No. 9. Digestive Glands.

* Journ. Postal Micr. Soc., v. (1886) pp. 210–8 (2 pls.), from 'The Analyst.'

(Plate 9. Vert. sec. of Leaf of Butterwort showing digestive hairs—slightly diagrammatic.)

Sec. II. Animal Histology. No. 8. Spermatozoa in the Invertebrata. (Plate 9. Spermatozoa of Invertebrata.) No. 9. Reproduction in Lamellibranch Mollusca. (Plate 9. Ovary of Mussel—*Mytilus*.)

Sec. III. Pathological Histology. No. 8. Acute Parenchymatous Nephritis (Acute Bright's Disease.) (Plate 8. Acute Interstitial Nephritis.) No. 9. Chronic Interstitial Nephritis. (Plate 9. Kidney in Leucocythæmia.)

Sec. IV. Popular Microscopical Studies. No. 8. Microbes (*contd.*). (Plate 8. Growing-points of stems.) No. 9. Roots, Stems, Growing-points and Leaves. (Plate 9. V.S. of Leaf of *Eucalyptus globulus* × 50.)

CROOKSHANK, E. M.—**Manual of Bacteriology.**
2nd ed., xxiv. and 439 pp., 137 figs. and 29 pls., 8vo, London, 1887.

Doherty's (A. J.) Histological Slides. *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 52.

Harpe, E., de la.—See *Peyer, A.*

JAMES, F. L.—**Clinical Microscopical Technology.**
[I. Introductory. II., III. Examination of Urine.]
St. Louis Med. and Surg. Journ., LII. (1887) pp. 96–9 (1 fig.) 160–2, 231–3.

" " **Cleaning and drying Containers.**
[Directions for getting rid of minute quantities of water left in bottles after washing them, where the bottles are intended for holding oleaginous or balsamic mounting media or cements.]
St. Louis Med. and Surg. Journ., LII. (1887) p. 230.

LATTEUX, P.—**Manuel de Technique microscopique ou Guide pratique pour l'Étude et le Maniement du Microscope dans ses applications à l'Histologie humaine et comparée, à l'Anatomie végétale et à la Mineralogie. Introduction de M. le Professeur Trélat.** (Manual of microscopical technique, or practical guide to the study and management of the Microscope in its application to human and comparative histology, to vegetable anatomy, and to mineralogy.)
3rd ed., xvi. and 820 pp., 385 figs. and 1 phot., 8vo, Paris, 1887.

[MANTON, W. P., and others.]—**What practical use can the druggist make of the Microscope?** *The Microscope*, VII. (1887) pp. 55–6.
[By testing all crude drugs that come into his possession.]

" " " **Elementary Department.** First and Second Lessons. "Cleanliness is akin to godliness."
[Lessons based on actual laboratory work, placing "before the beginner, in the most elementary and primer-like manner, the details of microscopical technique."]
The Microscope, VI. (1886) pp. 76–80, 106–10 (2 figs.).

Naturalist's Laboratory. VII. Laboratory Furniture (*concld.*).
[Describes and figures a "Naturalist's Store Case" for Microscopes, dissecting tools, reagents, objects, &c., and so arranged that "the worker can construct his own cabinet piecemeal from time to time with but very little skill and at a very trivial expenditure." Also a "Book box for the storage of microscopical specimens."]
Knowledge, X. (1887) pp. 160–2 (2 figs.).

Peyer, A.—**Atlas de Microscopie Clinique.** (Atlas of Clinical Microscopy.)
Transl. by E. de la Harpe. 2nd ed., 100 pls., 4to, Paris, 1887.

Pharmaceutical Era, a monthly exponent of Pharmacology in all its departments, including Chemistry, Botany, Microscopy, and of the Art of Pharmacy. (A. B. Lyons, M.D., Editor.) Each No. 32 pp. Detroit, Mich., 1887.

QUEEN'S (J. W.) **Needle-holder.**
["It is a sort of universal chuck operated by a concentric screw-collar, and will hold needles of various sizes."]
Micr. Bulletin (Queen's), IV. (1887) p. 15 (1 fig.).

SESTINI, F.—**Sopra un nuovo metodo per discernere il burro artificiale.** (On a new method of distinguishing artificial butter.)
Atti Soc. Tosc. Sci. Nat.—Proc. Verb., V. (1887) pp. 218–23.

STOKES, A. C.—**Microscopy for Beginners, or Common Objects from the Ponds and Ditches.** 308 pp., 8vo, New York, 1887.

TRÉLAT, U.—See Latteux, P.

PROCEEDINGS OF THE SOCIETY.

Meeting of 13th April, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 9th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Slides (13) of Diatomaceæ	*Mr. B. W. Thomas.*
Photomicrographs of *Floscularia*, *Melicerta*, and *Stephanoceros*	*Mr. J. B. Robinson.*
Photomicrographs of Snow Crystals	*Mr. A. W. Waters.*

Mr. B. W. Thomas's letter was read in reference to the thirteen slides of diatomaceæ, in which he suggested the necessity of having standard Maltwood finders.

Mr. Beck said there had been spurious imitations of Maltwood finders, so that it was impossible to guarantee the quality of all that were in existence. All the genuine ones, however, agreed with one another to within 1/1000 in. Mr. Maltwood originally asked them to carry out his plan, and they had a glass plate engraved, and all the finders they had sent out had been photographed from this. No doubt some enterprising American had endeavoured to make Maltwood's finders so as to offer them for a few pence less than the genuine ones. All the genuine Maltwood finders were made to the same standard, and there was no practical difficulty in insuring their correctness.

Photomicrographs of living rotifera (*Floscularia*, *Melicerta*, and *Stephanoceros*), by Mr. J. B. Robinson, were exhibited; also photomicrographs of snow crystals taken at Davos Dörfli, by Mr. A. W. Waters, showing some remarkable forms.

Mr. T. C. White exhibited a series of photomicrographs which he had recently taken, showing the results of the method of cutting off some of the superfluous light by means of a sliding diaphragm, so as to be able to admit just enough to bring out the detail and nothing more. The specimens shown were printed on Eastman's bromide paper, instead of silver paper, which he found brought out the character of the detail very much better.

The President was sure it would be interesting to all to note the improvements shown in these productions by Mr. White. The photomicrographs were certainly remarkably clear, and showed a distinct advance upon anything he had seen before.

Mr. F. R. Cheshire said that the small bottle which he held in his hand contained an object unmounted, which was very rarely seen, because ex-

tremely difficult to discover even by experts in the art of bee culture. It was generally well known that in the bee-hive all the eggs were usually laid by the queen, whose body contained about 300 various tubes, and who, under favourable conditions, was capable of laying even more than 3000 eggs in the course of twenty-four hours. After the accidental loss or intentional removal of the queen, the bees take some of the eggs remaining in the hive, and by a special feeding of the resulting larvæ are able to produce fresh queens. If, however, it should happen that in a hive which has lost its queen there are no eggs available for this purpose, it is found that some of the workers under some special circumstances, which could not be very clearly explained, became capable of laying eggs, but that such eggs produced drones only. These bees were known as fertile workers, and though there could be no doubt as to their frequent existence, they were very difficult to catch, owing to the fact of their being exactly the same in appearance as the ordinary workers. During the whole of his experience he had never but in three cases been able to secure specimens, and, besides these, only one or two isolated cases of verifying them had occurred in England. In the bottle to which he had referred were two of these fertile workers, having the ovaries drawn out of the bodies and attached to their stings and abdominal plates, so as to show that they really were workers. There was a remarkable peculiarity to be observed in connection with the ovarian tubes of these insects; every ordinary worker possessed an undeveloped ovary which it was very difficult both to detect and to dissect; but when under the influence of some stimulus the worker became fertile, a number of points began to appear in the tubes which afterwards became developed, and it would seem that the eggs were developed in alternation, an examination of the ovarian tubes showing them to contain developed eggs alternating with others in an undeveloped condition (as drawn on the black-board), and of which some very curious instances were seen in the specimens before the meeting. He hoped to be able to mount them, and if successful in doing so, he should have great pleasure in showing them at their next meeting.

Mr. Tebbs asked if there was any difference in appearance between the ordinary workers and those which Mr. Cheshire had just been describing?

Mr. Cheshire said that externally there was no distinguishable difference between them, though it was possible they might weigh a little more; dissection made the difference clear at once. They could only be detected when in the hive by the attentions which were paid to them by the other bees. A curious fact in connection with the queen was that although she had much smaller intestines than a worker, she was yet capable of producing nearly four times her own weight of eggs in the course of a day; and it would naturally seem very remarkable how so much nitrogenous matter could be produced by one whose organs of digestion and assimilation were so inferior in proportionate size, being actually less than those of a worker. But the fact was the queen did not herself digest her own food, but was fed upon a highly nutritive fluid from a gland in the head of the worker, in whose body the process of digestion had been carried on, and who conveyed the product to the queen by a special apparatus connected with the tongue. In the body of the fertile worker it was worth noting that no pollen was found such as formed the food of the ordinary bee, and this showed the fertile worker to be fed, like a queen, by the other bees.

Mr. Karop inquired how it was that Mr. Cheshire knew that the eggs developed alternately in the way he had stated, seeing that the opportunities for observation were so very rare?

Mr. Cheshire said it was only from what he found by examination of the ovarian tubes, and seeing that now and then there were gaps such as he had drawn, that he had ventured to give this as a suggestion. He rather intended the remark as a seeker after further information.

Prof. Bell asked if there was any reason to be assigned why one worker should be preferred to another in becoming fertile? Were there many such, or only a few in the hive which underwent this change?

Mr. Cheshire said it had been thought by some that these workers had been brought up in cells adjoining that of the queen, and might, therefore, have to some extent been nourished by some of the special food given to the larva of the queen; but since fertile workers had been found in hives which had never produced queens, this idea was hardly tenable. He thought it might be due to some special stimulus exerted by the bees under a strong desire to obtain eggs, though it was difficult to say of what nature the stimulus actually was.

Prof. Bell suggested that this bore some analogy to male lactation, as when a hare was shot some time ago in America suckling its young, and was afterwards found to be a male. The point of his inquiry, however, was how these workers became in the first instance induced to lay eggs—whether there were any stimulating circumstances which promoted their development? There appeared to be no doubt that attention was paid to them afterwards; but was there nothing which went before?

Mr. Cheshire said this was a question upon which he was seeking information. He was quite unable at present to answer it; but since all workers were at first fed in the larval state in the same manner as those intended for queens, and that the queens had this diet through all their larval development, it was highly probable that some of the worker larvæ were so fed for a longer period than others. Such would be especially favourable subjects for conversion into fertile workers.

The President said the point appeared to be whether the attention given to these workers was a cause or only an effect of the alteration in their condition.

Mr. Cheshire could only say that there was something about the queen which had some special fascination for the workers. They would come upon a knife which had been used to dissect a queen, or on the hand of a person who had taken up a queen. He had seen a rose-leaf upon which a queen had been placed visited in an inquiring manner by bees for many days afterwards, and the same thing occurred in the case of the fertile worker. Her body, although she had never copulated, attracted bees most singularly after she had been completely dissected.

Prof. Bell asked whether there could be any doubt as to the fact that these bees were really workers?

Mr. Cheshire said there could be none whatever; the queens were distinctly different in every part of their anatomy, so that there was no possibility of making a mistake.

Mr. Crisp called attention to the earliest known compound Microscope, one by Campani, of Rome, made at some time prior to 1665, as was evidenced by the absence of a field lens to the eye-piece.

Zeiss's new form of adjustable nose-piece was exhibited, in which the objective was made to slide on and off the nose-piece in an inclined plane, which insured its not touching the object when being changed.

Mr. P. H. Gosse's paper "On Twelve New Species of Rotifera" was read by Prof. Bell (*supra*, p. 361).

The President said that the Council had felt from time to time some responsibility as to the matters to be brought before the meetings, as well as objects of interest for exhibition, and their feeling was that it would be very desirable if there could be more talking and more exhibiting on the other side of the table. If some of the Fellows would (as Mr. Cheshire had done that evening) give some description of objects of interest or of recent observation, it would greatly add to the usefulness of their meetings.

Mr. Badcock said that, adopting the suggestion just made by the President, he might mention that he knew where to find something which at the present time was rather rare. In Victoria Park there was a pond where *Dendrosoma radians* and *Floscularia* could be found in enormous abundance, also *Brachionus* in several varieties; *Epistylis* in several species, with many other kinds of pond life, including Polyzoa, just now hatching out from the egg. The pond was one of the most extraordinary for the number of things which were to be found in it that he had ever known. If any Fellows of the Society interested in the matter would call upon him, he should be happy to point it out.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Melicerta conifera.*

Mr. F. R. Cheshire:—Fertile Worker Bees.

Mr. Crisp:—(1) Campani's Compound Microscope. (2) Zeiss's Adjustable Nose-piece.

Mr. J. B. Robinson:—Photographs of living Rotifera: *Floscularia*, *Melicerta*, and *Stephanoceros.*

Mr. B. W. Thomas:—Slides (13) of Diatomaceæ.

Mr. A. W. Waters:—Photographs of snow crystals.

Mr. T. C. White:—Various Photomicrographs illustrating his note.

New Fellows:—The following were elected *Ordinary* Fellows:—Col. C. K. Brooke and Messrs. E. Dadswell, D. De Vere Hunt, L.R.C.P., A. Mantle, M.D., and R. Pinkney.

Meeting of 11th May, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 13th April last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Bousfield, E. C., A Guide to the Science of Photo-micrography; containing Exposure-Table and rules for working. 69 pp. and Table. (8vo, London, 1887)	*The Author.*

Crookshank, E. M., Photography of Bacteria. xix. and 64 pp., 22 pls. (8vo, London, 1887) .. .. *The Author.*
Beale, L. S., The Mystery of Life. 71 pp. and 2 pls. (8vo, London, 1871) .. .. ”
—— Life Theories; their Influence upon Religious Thought. viii. and 97 pp., 6 pls. (8vo, London, 1871) .. .. ”
—— Bioplasm: an Introduction to the Study of Physiology and Medicine. xvi. and 345 pp., 22 pls. (8vo, London, 1872) .. .. ”
—— On Life and on Vital Action in Health and Disease. 110 pp. (8vo, London, 1875) .. .. ”
Sixty-two Slides of Entomological Subjects .. .. *Mr. J. Deby.*

The President said that some time ago an alteration was made in the bye-laws, under which 100 Presidents of other Scientific Societies were eligible for election as ex-officio Fellows, and 78 Presidents were so elected. It seemed, however, that the Presidents of the Royal Society, the Linnean Society, the Royal Society of Edinburgh, and the Royal Irish Academy had not been included, probably because the eminence of these Societies would cause it to be assumed that their Presidents would be elected as a matter of course. The meeting now, no doubt, would be pleased to agree that the Presidents he had mentioned should be added to the list.

This was agreed to unanimously.

Mr. Crisp called attention, amongst the donations, to Dr. Crookshank's new work on the Photography of Bacteria; also to a number of slides of hair which Dr. Ondaatje, of Ceylon, had forwarded to the Society with a request for information as to its peculiarities of structure. If any Fellow would take the slides for examination and report to the next meeting, they would be glad to lend them for the purpose. Attention was also called to the intended re-delivery by the President on the 16th instant of the lecture which he gave with such success at the meeting of the British Association in Canada.

Mr. Deby presented 62 slides, chiefly of micro-hymenoptera, which came from the collection of the late Mr. Frederick Smith. There was also amongst them a complete series of slides illustrative of the development of the larva of a *Pediculus* from its first coming out of the egg to its mature condition.

Prof. Bell said that the late Mr. Frederick Smith was so careful an observer and collector as well as so skilful a mounter, that he felt sure that the present they had received was even of greater value than perhaps could be gathered from what Mr. Deby had said about it.

The President thought that the best thanks of the Society were due to Mr. Deby for his valuable donation, and a vote of thanks to him was unanimously carried.

Mr. J. Mayall, jun., said that he took it for granted the Fellows were interested in whatever concerned the history of the Microscope, and would therefore be glad to know of any new facts which tended to throw light upon the subject. They were told by some of the best authorities that the notes by Roger Bacon could hardly be considered as demonstrating that he had a practical knowledge of the use of magnifying lenses, and that his claim to be the inventor of them must be set aside. Fracastoro,

the eminent Italian physician, had referred to the magnifying power of lenses in a vague manner in his 'Homocentrica,' published in Venice in 1538; but this reference did not point to practical knowledge. Giovanni Baptista Porta had also been credited with the invention; but later writers, including Poggendorff, were doubtful if such was the fact. Libri was inclined to credit Galileo with the authorship—at least, of the combinations forming telescopes and Microscopes; but, on the other hand, it was certain that telescopes were known in Holland before Galileo's construction of these instruments. The evidence which he had come across lately conclusively showed that magnifying glasses were used at least as early as 1513–1520, for in the celebrated portrait of Leo X. by Raphael the Pope is shown holding one in his hand. This picture was painted between 1513 and 1520, as the Pope was elected in 1513, and Raphael died in 1520. He had brought to the meeting a volume which had been lent for the purpose by Mr. Quaritch, and which contained an engraving of Raphael's portrait of Leo X., so that the Fellows would be able to inspect it after the meeting.

During a recent visit to Florence he also paid some attention to the Microscopes which had been attributed to Galileo. It was, of course, rather difficult to say in such matters what was really authentic and what was not; but when these instruments were shown at the Loan Collection at South Kensington, there were suggestions made that they had been prepared for that exhibition, though he was assured by Prof. Meucci that they could be identified certainly since 1670, if not earlier. He could not, however, help noting that all the early telescopes made in 1660, or about that time, had cardboard tubes, and wood or horn cells for the lenses, whereas these Microscopes were made with substantial brass body-tubes with strong and well-made screw threads and firm tripod support. He could only say, therefore, that if the Microscope makers had arrived at that stage of perfection in Galileo's time, they had reached a point not attained by his successors until many years afterwards.

Mr. Mayall, in reply to an inquiry as to the supposed lens from Nineveh, said he could not add to what he had already stated in the Cantor Lectures, viz. that he did not find this so-called lens sufficiently clear to be used for magnifying purposes. It was made of rock crystal, and he thought that whoever intended to use it as a lens would have selected a piece without the veins across, which so marred it for that purpose, though, regarding it as an ornament, they rather added to its beauty. He thought Sir David Brewster had been rather hasty in coming to a conclusion about it. There had been also two pieces of glass found which had been taken for lenses, being plano-convex. One it was not possible to see through, the other was partly polished and might have been used as a burning-glass; but he had spoken to many authorities about them, amongst others to Mr. Madan, and they seemed of opinion that they were intended to be used as ornaments for the person, possibly for the helmet, or for the shoulder of the tunic.

Mr. J. Mayall, jun., also described a Microscope which had come from Japan. It was made after one of the old upright tripod models, and had a ring of inlaid silver ornamentation at both top and bottom, which was made with characteristic skill; but the person who had produced the instrument, though he had provided a place for the objective, had omitted to make any provision for the eye-piece.

Mr. Crisp remarked that though there was no place for lenses, yet there was an eye-piece guard to keep the dust out.

Mr. J. Beck said he had been examining the Microscope, and he could only say that he thought it a great libel upon the Japanese to attribute such a thing as that to them—a bogus Microscope. He could only suppose that it was the work of some amateur who got some Japanese rings of inlaid copper, and made the rest himself. Any one had only to look at the so-called fitting of the tube—which was no fit at all—to see the class of work, and for his part he did not believe it was Japanese work at all; there was English milling on the pillars. He had a large number of Japanese instruments, the workmanship of which was as fine as anything produced here.

Mr. Mayall said it would be folly to declare without actual knowledge that it was Japanese work, but it was quite certain that it was obtained from Tokio, and that it came direct here from Yokohama. Probably milling tools of English manufacture might have been used, as many other kinds of tools were used in Japan, and the ornamentation was undoubtedly Japanese work.

Mr. Deby said that many scientific instruments of English make were sent out to Japan, and he remembered seeing on one occasion 64 first-class Microscopes sent there by order of the agent of the Japanese Government. If, therefore, the people were well acquainted with Microscopes made by Mr. Beck and others here, it would be useless for any one there to produce such a one as that upon the table, as they would be quite certain that no one would purchase it.

Dr. Maddox's paper 'On the Different Tissues found in the Muscles of a Mummy' was read by Mr. Crisp, Dr. Maddox being unfortunately still unable to attend the meetings of the Society.

Prof. Bell said it was exceedingly interesting to find that a people who were so despised at the present time had succeeded in preserving the tissues of the body in this very remarkable way.

Prof. Bell gave an account of a recent visit which he had paid to M. Pasteur's laboratory in Paris.

The President felt sure that the Fellows were very much obliged to Prof. Bell for the very interesting account which he had given them, and for which their thanks were due.

Mr. Deby called attention to a series of double-stained sections of the rare parasitical plant *Brugmansia Löwii*, one of the Rafflesieæ, but differing in its being hermaphrodite. It grows on the overground roots of a species of *Cissus*, and was collected by him in 1884 in the Raritan range of mountains in Central West Sumatra. The sections show the development of the plant from the time it begins to raise the bark of its host as a minute tubercle up to the complete maturity of the ovules. The double-staining allows of distinguishing the limits between the tissues of the parasite and of its host, which on unstained sections cannot be determined.

The formation of the locula of the ovary is very remarkable, and partakes more of a fungoid growth than phanerogamic.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Cordylophora lacustris.*
Mr. Crisp:—Japanese Microscope.
Mr. Deby:—Series of sections of *Brugmansia Löwii.*
Dr. Maddox:—Photomicrographs in illustration of his paper.
Mr. J. Mayall, jun.:—Print of Raphael's Portrait of Leo X., with a hand magnifying lens, painted about 1513.
Mr. E. M. Nelson:—Diatoms in balsam shown with Lieberkühn.
Dr. Ondaatje:—Slides of hair.

New Fellows:—The following were elected *Ordinary* Fellows:— Messrs. H. W. Carr, G. M. Dawson, D.Sc., F.G.S., Lucien Howe, M.R.C.S., and Miss V. A. Latham; and as

Ex-officio Fellows:—The Presidents of the Royal Society, the Linnean Society, the Royal Society of Edinburgh, and the Royal Irish Academy.

R. L. M. del ad nat.

West, Newman & Co. lith.

Muscle of a Mummy.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1887.

TRANSACTIONS OF THE SOCIETY.

IX.—*On the Different Tissues found in the Muscle of a Mummy.*

By R. L. Maddox, M.D., Hon. F.R.M.S.

(*Read* 11*th May*, 1887.)

Plate X.

To some it may be a matter of surprise, to others a question of utility, to have gone back amongst the dead of remote ages in search of a subject for microscopical examination, whilst on every side we are surrounded by living organisms whose structure is unknown. Yet let me venture to hope the result which I now have the honour to bring to the notice of the Fellows may justify the selection. Whatever may be the opinion entertained of this record of the examination, it must be admitted there is one point upon which the dead doth not speak, nor can the living offer more than silence, and that is whether a thousand or two thousand or more cycles have slipped away "with the years beyond the flood" since this muscle-structure possessed life. The time, however, has certainly been beyond a period in which we could fairly hope for the preservation and identification of any part of the minute organic tissues of either the muscular, vascular, or nervous systems.

It was to satisfy myself upon this point, but more especially as regards the preservation of the striated character of voluntary muscle, that the examination was undertaken. Very possibly others have previously made like researches, but the limited means at my disposal have not enabled me to discover any record of a similar examination. Should such be within the knowledge of some of the Fellows whose opportunities have been greater, it is still hoped this paper may extend our knowledge and dispose of some of the difficulties that attend such studies.

No doubt, in the present instance, much is due to the very careful way in which the preservation of the dead was carried out, for in two

EXPLANATION OF PLATE X.

Fig. 1. Fibrillæ in mummy muscle × 200.
„ 2. Remains of blood-vessels (?) in mummy muscle × 200.
„ 3. Broken blood-vessel in mummy muscle × 200.
„ 4. Delicate nerve-fibres in mummy muscle × 200.
„ 5. Ditto.
„ 6. Ditto.
(All the figures have been reduced from 400 to 200 diam.)

other examinations all trace of minute structure was lost, the tissues being so impregnated with the asphalt, pitch, or resinous gums and other materials used in the process of embalming, as to be useless under any of the methods of investigation that were adopted with success in this case.

About nineteen years ago there was handed to me a portion of a human mummy, the arm (I believe of a female), obtained before 1853 from one of the many Egyptian tombs, by a friend since deceased. A small piece was cut from one of the muscles—if I remember correctly, the triceps—which had been exposed by the removal of the various investing bands of linen, and carefully wrapped in note-paper, and put aside for a more convenient time, and thus came to be forgotten until a few weeks since. The little piece that was removed was about $1\frac{1}{4}$ in. long, pliable, and looking closely like a small tuft from an old cocoa-nut fibre mat or a dirty bit of spent tan.

A very cursory examination proved so attractive, that it was determined to no longer delay a more strict investigation. The question was how best to proceed, and in order to vary the methods the following reagents were used. The parts taken from the bit of muscle were cut from each end, also from the middle, and placed to soak in them for a fortnight:—

1. Glycerin 4 dr., glacial acetic acid 4 m.
2. Glycerin 4 dr., liquor potassæ (B. Ph.) 1 dr.
3. Glycerin 4 dr., sweet spirit of nitre 2 dr.
4. Glycerin 4 dr., saturated solution of boracic acid 1 dr.
5. Glycerin 4 dr., glac. acet. acid 4 m., and chloride zinc 6 gr.
6. Distilled water 4 dr., glac. acet. acid 2 m.
7. Saturated solution of salicylic acid.
8. Distilled water 3 parts, hydrochloric acid 1 part.
9. Distilled water 6 parts, nitric acid 1 part.
10. Distilled water 2 parts, rectified spirit 1 part.
11. Distilled water 16 parts, chloral hydrate 1 part.
12. Equal parts of this solution and rectified spirit.
13. Turpentine.
14. Chloroform.

15. A portion of the muscle was boiled for ten seconds in a little distilled water.

16. A similar piece was boiled for the same time in equal parts of distilled water and rectified spirit. These portions were allowed afterwards to soak in these fluids for three or four days. It may here be remarked that the boiling shrank the tissue very much, and rendered it tough and elastic, possibly from the gums used in the embalming process.

As several of these reagents offered no peculiar advantage, only those which proved most useful will be now mentioned.

No. 1 enabled me to separate the fibres into smaller bundles by means of needles and the dissecting Microscope, but did not allow of any perfect separation into fibrillæ.

No. 5 permitted the dissection to be carried further and to bring into view numerous fibrillæ, also a blood-vessel filled with rather coarse granular contents.

Nos. 8 and 9 allowed the compression of the fibres until they pre-

sented only a finely granular appearance, but in this could be detected numerous fine fibres of different refractive power from the rest of the substance. These delicate fibres with high powers could be traced into different planes forming a plexus.

No. 16 permitted the examination of similar fine fibres to be carried perhaps a little further.

The objects, when prepared for the purpose of examination, were temporarily mounted either in a saturated solution of potassic acetate and distilled water equal parts, or in distilled water with such portions of the reagent that remained adherent to the small portion of muscle that was selected.

In order to avoid assuming the correctness of my own interpretation of the appearances presented under the Microscope, every endeavour was made to photograph the structures, but where the delicate and the densely coloured portions were in the same field of view, it was found impossible to distinctly render the former, such as the fibrillæ and nerves, the same becoming through over-exposure too feeble to print with fair definition in the positive, before the exposure had been long enough to impress the image of the denser parts, consequently I was driven to the use of the pencil and camera lucida to portray these structures—structures which it was not in any way anticipated would be thus far found intact. The figures of plate X. have been drawn to a scale larger than the photomicrographs, or really than necessary, but this was done expressly that the parts might be more readily distinguished. A lower magnification was tried, but the result was less satisfactory, and it was more difficult to use.

The macroscopical appearances have already been alluded to. In the microscopical examination the first thing that was noticed in a large number of the portions that had been teased out by the needles was a coarse, granular striation, crossing at irregular intervals at right angles to the course of the fibres. This is shown in fig. 5 and in photograph No. 1. I have no satisfactory theory to offer to account for this peculiarity, which was evidently not directly due to the pressure of the bandages, as in many of the bits of muscle they were far too near each other for that idea, but it struck me as the process of embalming was often carried out or begun very shortly after death, that in this case it might have been before the *rigor mortis* had passed away, and that the albuminoid fluid substance of the muscle had been coagulated, and as it seems impressed or imprisoned under the rigor of the muscular structures.

The next notable appearance was the preservation of the muscular fibres, but unfortunately minus their own striation. In some of the prepared specimens, the muscular structure presented a beautiful wavy character which did not admit of perfect straightening, and in some cases where one of the needles used, a thin pointed flat one, had been pressed somewhat heavily on the fibres, these had been broken up into finer bundles and finally pressed out or broken up into their respective fibrillæ, whilst here and there in other specimens fibrillæ as fine lines could be seen stretching across from fibre to fibre of the teased-out muscle. The former only have been represented in fig. 1. An unsuccessful attempt has been made to photograph both conditions. Photographs 2 and 3.

In numerous specimens a peculiar appearance of aërolated lines was noticed, which generally followed the course of the fibres, but sometimes ran rather obliquely across them. These looked very much like long interspaces, varying slightly here and there in width, that had been filled with some fluid that had coagulated and imprisoned minute air-spaces. One specimen was photographed for part of its course which was more than double that depicted in the printed photograph No. 4. The slight swellings are visible in the part represented. Several of these aerolated spaces are also shown in the figs., especially fig. 2. They remain a puzzle to me, but they led me to search most carefully for some perfect minute vessels, and after spending much time over the slides I was rewarded by finding a small vessel charged with rather coarse granular contents lying between the fibres. It had been broken across in its course, and separated only a very short distance from it were likewise three small broken portions of the same vessel. The attempt to reproduce this by photography, photograph 5, has not been as successful as desired on account of the non-actinic colour of the structure, hence it has been figured more highly magnified, fig. 3. Whether the contents were blood constituents greatly altered by the process of embalming or perhaps by the injection of some preservative liquid is doubtful, but the appearance is sufficiently characteristic of its vascular nature. The use of immersion lenses disclosed nothing more satisfactory, as regards the granular contents, though some of the few separated granules seemed to have a kind of halo round them. Thus far the examinations proved very interesting. Two apparently different vessels or empty tubes were dissociated from the fibres by the needles, but it appears to me they cannot safely be said to belong to either the lymphatic or vascular systems, for some parts of the muscle had been invaded by a mildew growth. Curiously this mycelium had spread *across* the fibres and not in the direction of their length. These two tubes appeared too large to be the basic mycelium tubes connected with the smaller branches of what were regarded as due to a growth of *Penicillium* from the few conidia found lying amongst them. These vessels or tubes were photographed in order to furnish an idea of their appearance, and on the nature of which I do not venture to offer any definite opinion. Photograph 6.

During the examination of many of the prepared specimens, where the fibrous structures had been purposely compressed, the eye continually glimpsed minute fibres of a different refractive power from the other parts, running for a short distance in the substance of the muscle, and then lost to view. This led me to endeavour to prepare some of the specimens so that their course could be more completely followed. By very careful focusing the fibres could now be traced through different levels, although the plexus brought into view is figured in each drawing as if it occupied only one plane. Figs. 4, 5 and 6. Without much hesitation, I think these fine fibres must be regarded as nerve-fibres. They were not seen in any of the specimens as long as the muscle structure retained its fibrous appearance, but when it was softened, compressed, and had assumed a more or less finely granular character, then these delicate nerve-fibres were brought into view. The mode of preparation that gave perhaps the best results was when boiled for ten

seconds with water and rectified spirit, or when water with nitric acid had been used as the reagent. Every effort to photograph these structures failed, the brown non-actinic colour and density of the substance prevented the necessary differentiation, though perfectly visible under the Microscope with careful focusing. These fine fibres appeared in part as continuous bright lines, in part as grey lines, according to the position of the mirror. Unfortunately the stock of osmic acid was exhausted or it would have been used to try and render these fine fibres yet more apparent. Under none of the reagents used did the muscle structure afford any perfect evidence of the peculiar striation belonging to voluntary muscle, but some of the fibrillæ appeared to be made up of minute dots united in line, though how far this may have been inherent to the structure, or how far due to the general coagulation that was apparent in the highly compressed and softened muscle, is doubtful; but this much may be noticed, that the purposely softened muscle in which the nerve-fibrils were most visible, presented no trace of perfect muscular fibrillæ.

Although, correctly speaking, not belonging to the microscopical side of this interesting subject, this paper would be much more incomplete without some notice of the acknowledged methods of embalming, for the examination of a specimen kindly sent to me by Prof. Stewart of the Royal College of Surgeons proved absolutely useless, the flesh apparently having been placed in a bath of melted bitumen, or something of the kind, by which all structure was lost, and also in another specimen, for which I was indebted to the kindness of Mr. Shore, manager of the Hartley Institution, Southampton, which was somewhat brittle, and though treated with the same reagents, furnished no satisfactory results; still it is feared, even with this assistance, we shall find no sufficient clue to the method of preservation used in the present case. To enter into all the details would far exceed the limits of this paper, and the subject must, therefore, be but cursorily dealt with.

Whatever the origin of embalming, the process was perfected in Egypt. Besides the description given by Herodotus of the different methods, some instructions have been found in the Rhind papyrus. All the great cemeteries had their establishments for the reception and embalming of the dead, and it is stated that in those belonging to the necropolis of Memphis, there were always from 500 to 800 corpses passing through the different processes. Herodotus explains that the brains were removed through the nostrils, the intestines by an incision in the left side of the abdomen, which was then cleaned with palm wine, and afterwards filled with myrrh, cassia, &c., and the body steeped for many days in a solution of natron, an impure soda-salt found in the Natron Lake of the Libyan Desert in Upper Egypt. After the steeping, the body was handed to the swathers and bandaged with gummed cloths, and made ready for the coffin. The cost of the different methods is given as varying from 243*l.* to 96*l.*—the less costly method. This consisted in filling the abdomen with cedar-tree pitch or pine pitch, the body being steeped in the natron bath, the contents of the abdomen being allowed to escape or eviscerated by other means. The corpse of the poor was placed in natron for many days (70), after rinsing the abdomen with "syrmæa." Asphalt was said to be used with the more costly methods, and wax but

rarely. In some cases, it is stated, the body was immersed in melted bitumen. A species of tanning was also employed. Sometimes the viscera, after cleansing, were replaced, but more frequently embalmed separately, and placed in a vase near the mummy, the emptied abdomen being filled with chips of cedar sawdust, and a little natron. The cast linen of the household was usually kept for the bandages. The swathing was begun at the toes and fingers, then carried over the whole body in numberless bands ; from 700 to 1200 yards of bandages, or strips three or four inches wide, it is written, have been unrolled from a single mummy. The mummies of Memphis are described as black and brittle, and those of the time of the Hebrews as yellow and flexible, the flesh even yielding to pressure, and the limbs capable of altered position without breaking. This flexibility is supposed to have resulted from the use of very costly injections of chemical solutions into the vessels, as the natron process largely destroyed the structures. The under bandages were dipped in spirit and applied wet. When Syrian turpentine came into use as in Thebes, the mummies were blacker than those of Memphis, both the bandages and body being greatly hardened. In later periods some of the bodies had an ashen grey appearance, others that were treated with bitumen were dark coloured and heavy. The methods described by Herodotus, Diodorus Siculus, and others, have been more or less confirmed by MM. Jomard, Royer, and Larrey, in their 'Description de l'Égypte.' The evisceration by incision is said to have been adopted for the rich. The mummies in which the cavities were filled with aromatic resinous bodies are somewhat olive coloured, with distinct features, the teeth, hair, and eyebrows remaining mostly perfect. Those in which the body had been filled with bitumen, are somewhat reddish, with a hard skin, and are not very alterable on exposure to the atmosphere, the features remaining moderately perfect. Those that have been salted do not differ much from the last, but the hair has generally dropped off, and the features are not so perfect. When the impure bitumen or pisasphalt was used internally, it was also supposed to have been used very hot, so as to impregnate all the tissues. The bodies that were only salted and dried remain less perfect, the features being destroyed, the hair removed, while the skin is hard and parchmenty. The Egyptian modes of embalming were copied by the Jews, Greeks, and Romans.*

The more perfect Jewish method was probably the one employed in preserving the mummy that furnished the muscle that has been the subject of this paper, though this must be accepted as a matter of speculation.

The appearances under the Microscope of living and recently dead muscle are not strictly alike, the latter has more opacity besides other differences. The muscle fluid, myosin, has been found to coagulate at 45° C., and the same temperature sets up rigor mortis, and at 75° C. the albuminoids become coagulated. In spite of the diligent physiological and microscopical researches that have been made in studying the complex character of living muscle, we are yet confronted by many

* For the rules and methods of embalming I am indebted to the pages of the Encyclopædia Britannica, 9th ed., the Penny Cyclopædia, and Kitto's Cyclopædia of Biblical Literature.

difficulties, and it is doubtful if the last words have yet been said in connection with its attributes and structure; hence we can hardly expect that the dead tissues of remote ages, no matter by whatever method preserved, should be found to closely correspond with the living or recently dead similar structures. We have lost the striation and its doubly refracting power, the sarcolemma and the long pointed nuclei, and how far the chemical substances, myosin, glycogen, inosit, creatin, &c., remain intact in the mummy muscle, is very doubtful. The withdrawal of moisture with the use of materials to delay tissue change we must expect will prevent any very perfect restoration as a whole of this highly delicate complex tissue. With the separation of the bundles of fibres into smaller ones, and these again into finer ones, all of which are held together by connective tissue, until we end at the fibrillæ, we must, it appears, for the present be content in our comparison of the recent muscular structure and the remote dead. To have gained this much with the addition of vessels and nerves, was worth the inquiry.

Note.—Since the foregoing was read, one of the Members of the Council, Mr. Julien Deby, has drawn my attention to a paper by Czermak,* published in 1852, containing the result of his examination of two Egyptian mummies, and having most kindly placed the article at my service, I am enabled to add this very brief summary of the interesting details of the microscopical examination. The mummies were those of an adult female and of a lad about 15 years of age, and dating from a period of 2000 years since; the former being in a very marked state of preservation, having been most carefully prepared and wrapped with about 4000 yards of bandages, though not a person of an exalted station. The boy was much damaged, hence the examination chiefly refers to the former. Czermak, after giving a general description of the condition of the different parts of the bodies, and alluding to the method of embalming and the excellent preservation of the female mummy, which he attributes especially to the natron used in the process, passes to the microscopical details, of which he gives thirteen very carefully drawn figures. On referring to these it will be noticed that Czermak was very fortunate, as he found the striation in one of the voluntary muscles—the sphincter of the eyelid—by making use of turpentine as the examining medium; but this medium failed entirely in my hands, and also upon making a further trial of the same. He does not appear to have obtained the separation into fibrillæ, as his figure is that of a bundle of fibrils. To accomplish this separation it seemed to me to be necessary to swell the tissues very gradually. There is another most interesting point in Czermak's paper, he having been able to recognise the axis cylinder in the fibres composing the median nerve of the arm. It will need no apology to offer a very brief notice of the microscopical details, as his paper may not be of easy access to many of the Fellows.

The following refers to the figures as given in the plate at the end of the paper:—

1. The cells with nuclei of a section of the nail of the ring finger of the female mummy.
2. A longitudinal section near the root of the nail.

* SB. K. Akad. Wiss. (Math.-Naturw. Cl.), ix. (1852).

3. Hair of the head of the female, showing the sheath.
4. A cross section of the hair near the root.
5. The cells of the inner sheath.
6. Henle's and Huxley's layers.
7. A transverse section of the muscle of the thumb, *flexor pollicis longus*, treated with water.
8. The cartilage cells of the ear of the small mummy.
9. Section of the cartilage of the patella, with the cells *in situ*.
10. Cartilage cells from the rib of the female mummy.
11. Nerve-fibres of the median nerve in which besides the nerve-substance the axis-cylinder can be also seen.
12. A few muscular fibres from the sphincter of the eyelid as seen in turpentine, showing the striation and other appearances.
13. A section of the fatty layer in the great toe of the adult mummy, with the fat-cells in position.

Czermak speaks of one of the former Presidents of the Society, Prof. Quekett, having shown him a figure of the hair of a mummy in one of the Nos. of the 'Microscopical Journal.' Unfortunately I am unable to specialise the number.

It will thus be seen that by the aid of the Microscope it has been possible to touch the fringe, and gather up a few threads of "the frayed border of the royal robe" worn long centuries since, but carefully folded up and laid aside as a legacy to the wardrobe of time.

X.—*Remarks on the Foraminifera, with especial reference to their Variability of Form, illustrated by the Cristellarians.*—Part II.

By Prof. T. Rupert Jones, F.R.S., F.G.S.,
and C. Davies Sherborn, F.G.S.

(*Read 8th June*, 1887.)

Part I. of this paper, in the 'Monthly Microscopical Journal' for February 1876, contained a synoptical Table of the published varieties of *Cristellaria*, from the time of Linné to 1840; and an attempt was made to reduce these numerous figured forms to their proper zoological positions, by referring them to the few best-pronounced types of *Cristellaria*. In the two plates illustrating the above-mentioned paper, there were figured a series of Foraminifera, all belonging to the Nodosarinæ; and they exemplified the gradual passage from the straight, many-chambered shell of this kind of Foraminifera to the most perfect spiral form. At the same time it was shown that the cylindrical and compressed shells of varying thickness were merely varieties of the same form. It has been thought advisable to continue the Table as a guide to future workers in this group of Microzoa; and in this paper the Cristellarians are now further zoologically tabulated to the end of 1860.

It having been found impossible, for want of space, to include those other groups of Nodosarinæ which are closely connected with *Cristellaria*, we have omitted hundreds of references to the many varieties of *Marginulinæ*, *Vaginulinæ*, and other sub-groups, which cannot, if regarded biologically, be separated from the *Cristellariæ*. The most striking series of these omitted forms will be found in a paper by Neugeboren, published in the Verh. Mitth. Siebenburg. Ver. Nat., ii. 1851, where a series of forty-five partially-coiled Nodosarinæ are figured, most of which have been elevated by him to the rank of "species." Others are to be found in a paper by M. Cornuel in the Mém. Soc. Géol. France, sér. 2, iii. 1848; in Reuss' "Westphälischen Kreide," SB. K. Akad. Wiss. Wien, xl. 1860, &c.

In drawing up the Table, five forms have been selected as the *chief types* around which to group the *Cristellariæ;* these are, *C. calcar* (Linné), representing the keeled and rowelled forms, and of which all spiral *Cristellariæ* are specifically varieties; and, as convenient sub-varieties of this, *C. cultrata* (De Montf.), representing the keeled forms; *C. rotulata* Lam., the keelless forms; *C. italica* (Defr.), the triangular-elongate forms; and *C. crepidula* (Fichtel and Moll), including all compressed-elongate forms. It must, however, be understood that these five varieties are not themselves to be considered as really distinct, but are used merely as available heads of divisions into which the *Cristellariæ* may be sorted. Some few subordinate names are kept, with the alliances indicated.

In the Table, the middle column gives the names bestowed by different authors upon the varieties which they have described as "species." Those names which we consider to be of sufficient value to be kept for classificatory purposes have been printed in larger type; while, on the other hand, those which are unmistakably the same as our recognised types are printed in smaller type, to indicate the advisability of allowing their pseudo-specific name to drop. There is certainly

a fictitious, though to some extent a practical, value in these pseudo-specific names, when the student is collecting and arranging Foraminifera, if he is desirous of distinguishing minute differences by nomenclatorial terms; but he should not be led to exaggerate the zoological value of such varietal forms and conditions. Further, were naturalists to use only such terms as might be approved of by exact biology, the discoveries and observations made by earlier authors would perhaps be too often forgotten or laid aside. Indeed, it is necessary to retain for classificatory purposes many names given by these earlier workers, and very desirable that observers should refer to these older works thoroughly, when seeking for comparisons and new names. Amongst the several Bibliographies of Foraminifera known to us, that appended to H. B. Brady's 'Report on the Foraminifera of the Challenger Expedition' is by far the best; it has carefully brought the literature of the subject into notice, and is very useful for the above-mentioned purpose of enabling the student to find what has already been done in this line of research.

Since 1860, the period at which our present Table closes, there have been published a very great number of papers on the Foraminifera; the labours of Reuss, Terquem, Karrer, and others having brought to our notice hundreds of forms, amongst which the Nodosarinæ predominate. Of these papers we do not propose now to treat; but it will be useful to refer to a work, by von Schlicht,* who, in a series of thirty-eight large plates, illustrating the Foraminiferal fauna of one deposit (corresponding, according to Hermann Credner,† to our Hempstead Beds of the Isle of Wight), devotes eight and a half quarto plates, containing two hundred and thirteen figures, to the *Cristellariæ* alone. To the delineation of other members of the Nodosarinæ (*Lagena* to *Marginulina*) he gives ten and a half plates, with two hundred and sixteen figures. Von Schlicht only grouped his specimens in "genera"; but von Reuss, in the SB. K. Akad. Wiss. Wien, lxii. 1870, carefully described most of the forms, making many new "species." The most cursory examination of these plates will show the extremely close connection existing between all the forms; and, having in hand the illustrations of so fine a series from *one* deposit, and therefore of so large a group of forms most probably living continuously in one area, and under one set of conditions, we are enabled to see in a striking manner how greatly one form can and does pass into manifold varieties, and how difficult it is to recognise the limitation of species, and say where they begin and where they end.‡

It only remains to again point out the completeness of the chain which has for its links the sub-groups *Lagena*, *Glandulina*, *Nodosaria*, *Dentalina*, *Marginulina*, *Vaginulina*, and *Cristellaria* (including *Robulina*); and again to draw attention to the infinite number of varieties, whose only claim to "specific" position consists in the varying curvature of the shell; other modifications, such as surface-marking, form and position of orifice, variable flattening of the shell, &c., being common to each of the several sub-groups above-mentioned.

* 'Die Foraminiferen des Septarienthones von Pietzpuhl,' 4to, Berlin, 1870.

† 'Elemente der Geologie,' 8vo, Leipzig, 1883.

‡ The recognition of these difficulties evidently led Dr. Goës to compile the valuable lists in his paper on "The Reticularian Rhizopoda of the Caribbean Sea," K. Svenska Vetensk.-Ak. Handl., xix. 1882.

SYNOPTICAL TABLE, SHOWING IN CHRONOLOGICAL ARRANGEMENT, AS NOTICED BY AUTHORS FROM 1840 TO 1860, THE VARIETAL MODIFICATIONS OF CRISTELLARIA CALCAR (LINNÉ), WHETHER KEELLESS, KEELED, ROWELLED, OUTSPREAD, TRIHEDRAL, OR ELONGATE.

1841. MICHELOTTI. "Rizopodi sopracret." Mem. Soc. Ital. Sci., xxii.			
p. 291, t. 2, f. 3	Robulina depressa Mich.	Cristellaria cultrata (De M.).	
p. 292 ,, f. 4	,, Cummingii Mich.		
p. 291 ,, f. 5	,, cultrata (de M.)		
p. 292 ,, f. 6	,, calcar (L.)	C. calcar (L.).	
1842. F. VON HAGENOW. "Rugen'schen Kreide." Neues Jahrbuch für Mineral. u.s.w., 1842.			
p. 569, pl. ix. f. 21	Planularia nodosa v. H.	A fragment of a *Flabellina*.	
p. 572 ,, f. 24	Cristellaria planicosta v. H.	C. cultrata.	
p. 573 ,, f. 25	,, obliqua v. H.	Ovate C. rotulata.	
1842. F. A. ROEMER. "Neue Kreide-Foram." Neues Jahrbuch, 1842.			
p. 273, pl. vii. B, f. 4	Planularia crepidularis Roem.	Varieties of a limbate *Planularia*.	
,, ,, f. 6	,, orbiculata Roem.		
1843. D'ARCHIAC. Mém. Soc. Géol. France, vol. v., Mém. No. 3.			
p. 370, t. 25, f. 3 *a*, *b*, *c*	Cristellaria truncata d'Arch.	Cristellaria italica (Defr.). Including (fig. 3) elongate var. [Jurassic.]	
1843. PHILIPPI. 'Beiträge zur Kenntniss der Tertiärversteinerungen der nordwestlichen Deutschlands.'			
p. 5, 13, t. 4, f. 27	Marginulina vel Planularia spirata Ph.	With large coil. Cristellaria arcuata (Ph.), Reuss, SB. W., 1855, xviii. p. 233.	Varieties of Cristellaria crepidula.* Near C. subarcuatula W. & J.
,, 12, ,, f. 28	,, ,, ,, arcuata Ph.	With small coil.	
,, 11, 69, 6, t. 4, f. 29	,, ,, ,, compressiuscula Ph.	With small coil; narrow.	
p. 41, 17, t. 4, f. 39	Planularia semicircularis Ph.	A broad and short C. crepidula.	
p. 40, 15, t. 4, f. 38	,, intermedia Ph.	C. arcuata (Ph.) Reuss (p. 233).	
p. 41, 16 (no figure)	,, oblonga Ph.	Not determinable from the description.	
p. 40, 14, t. 4, f. 37	Marginulina gladius Ph.	Narrow and thick C. crepidula. Cristellaria gladius (Ph.) Reuss. Sitz. Wien, 1855, xviii. p. 232 (figs. and synonyms).	

* We think it advisable to refer this accepted species to *Cristellaria* rather than to *Planularia*.

SYNOPTICAL TABLE—*continued.*

1845–46. A. E. VON REUSS. "Verstein. Böhm. Kreid."			
t. 8, f. 12	Cristellaria denticulata Rss.	*Planularia*, with sunken septa.	
„ f. 48	„ triangularis d'O.	C. rotulata, elongate, thick, triangular; nearly C. italica.	
„ f. 49; t. 12, f. 19; t. 13, f. 60–63	„ ovalis Rss.	„ short, thick, triangular; mostly C. italica. Fig. 63 is much like *C. carinatulus* (W. & J.).	
„ f. 50, 70; t. 12, f. 25; t. 24, f. 48, 49.	„ rotulata (Lam.)	C. rotulata; sometimes umbonate.	
„ f. 51	Nonionina compressa Roem. (?)	„	
t. 12, f. 27	Cristellaria navicula d'O.	„ elongate; near C. italica.	
t. 13, f. 54	„ complanata Rss.	*Planularia*, smooth = C. crepidula.	
„ f. 55	„ recta d'O.	Marginuline *Cristellaria*, near *Planularia*.	
„ f. 56	„ limbata Rss.	*Marginulina*.	
„ f. 57, 58; t. 23, f. 50, 51	„ intermedia Rss.	C. rotulata, passing into *Marginulina* and into *Planularia* (f. 50 and 51 are *Planulariæ*). Thick C. crepidula, or broad C. subarcuatula.	
„ f. 59	„ lobata Rss.	C. cultrata, subumbonate, with poor keel.	
t. 24, f. 46	Robulina lepida Rss.	C. rotulata, becoming elongate and Planularian.	
„ f. 47	Cristellaria lituola Rss.	„ elongate and Marginuline.	
1846. D'ORBIGNY. Foram. foss. Bassin tert. Vienne.			
p. 71, t. 3, f. 22, 23	Marginulina triangularis d'O.	Cristellarian.	Notice is drawn to these as indicating the difficulty of defining the boundaries of the nominal "genera."
p. 84 „ f. 24, 25	Cristellaria Hauerina d'O.	Marginuline.	
p. 85 „ f. 26–29	„ simplex d'O.	Fig. 26 is Marginuline; fig. 28, Planularian.	
„ „ f. 30, 31	„ cymboïdes, d'O.	Cristellaria crepidula, rather narrow.	
p. 86 „ f. 32, 33	„ compressa d'O.	*Planularia* (keeled).	
p. 87 „ f. 34, 36	„ arcuata d'O.	Marginuline.	
p. 88 „ f. 37, 38	„ Josephina d'O.	C. rotulata, with sunken septal lines.	
„ „ f. 39, 40	„ reniformis d'O.	Planularian.	
p. 89 „ f. 41, 42	„ lanceolata d'O.	*Planularia elongata* d'O. (Modèles).	
p. 90 „ f. 43, 44	„ semiluna d'O.	Planularia auris Defrance.	
„ t. 4, f. 1–3	„ crassa d'O.	C. cultrata, thick and with few chambers (C. acutauricularis, keeled).	
p. 91 „ f. 4–7	„ cassis (F. & M.)	C. cassis.	
p. 95 f. 8, 9	Robulina ariminensis d'O.	Cristellaria, near C. costata (F. & M.). Subvariety, with sunken septal lines.	

p. 96 „ f. 10–13	„ cultrata (De M.)	C. cultrata, with broad keel, umbonate and limbate.
p. 98 „ f. 14, 15	„ similis d'O.	„ with broad keel.
„ „ f. 16, 17	„ ornata d'O.	*C. costata*, subvar. Symmetrical and keeled; with partial ornament only.
p. 99 „ f. 18–20	„ calcar * (L.)	C. calcar. The septal lines less vorticial than in Fichtel and Moll's figures.
p. 100 „ f. 21, 22	„ echinata † d'O.	C. calcar. Subvar., ornamented with granules and some longitudinal marks.
p. 101 „ f. 23, 24	„ clypeiformis d'O.	C. cultrata, limbate, umbonate, and with rather narrow chambers.
p. 102 „ f. 25, 26	„ inornata d'O.	C. rotulata, thick and few-chambered.
p. 103 „ f. 27, 28	„ simplex d'O.	„ rather thick.
„ t. 5, f. 1, 2	„ austriaca d'O.	„
p. 104 „ f. 3, 4	„ intermedia d'O.	„ with subvorticial chambers.
„ „ f. 5, 6	„ imperatoria ‡ d'O.	C. vortex, keeled and umbonate.

1846. R. A. Philippi. "Verzeich. Magdeburg. Tert." Palæontographica, vol. i.

p. 81, t. 10A, f. 21	Nonionina Magdeburgica Ph.	Cristellaria cultrata (De M.); umbonate and limbate.

1847. Michelotti. "Terr. mioc. Italie septentr." Nat. Ver. Hollandsche Maatschap. Wetensch. Haarlem, 2 ser., iii.

p. 15, t. 1, f. 1	Robulina depressa M. (1841)	*Cristellaria.*
p. 14 „ f. 2	„ antiqua M. (1841)	C. rotulata.
„ „ f. 3	„ Cummingi M. (1841)	C. cultrata.
p. 13 „ f. 5 and 5_1	Cristellaria cassis (F. & M.)	C. cassis (F. & M.); subflabelline.
„ (not figured)	Robulina Haueri M.	C. cultrata, with numerous curved chambers.
„ „	Cristellaria Partschii M.	„ subcarinate.

1848. Cornuel. Mém. Soc. Géol. France, ser. ii. vol. iii. part 1 (Cretaceous).

p. 253, t. 2, f. 1–4	Planularia reticulata C.	Planularian *Vaginulinæ.*
„ „ f. 5–8	„ costata C.	
p. 254, „ f. 9, 10	Cristellaria lituola C.	Planularian *Marginulinæ;* fig. 11 is near Cristellaria subarcuatula.
„ „ f. 11–13	„ excentrica C.	
p. 255 „ f. 14–16	„ voluta C.	

* *R. aculeata*, Ann. Sc. Nat., vii. p. 289, No. 14.
† *R. calcar*, Ann. Sc. Nat., vii. p. 123, No. 12, var. ε, F. & M.
‡ *R. vortex*, Ann. Sc. Nat., vii. p. 288, No. 4.

Synoptical Table—*continued.*

1848. Johann Czjzek. "Foss. For. Wien. Becken." Haidinger's Naturw. Abh., ii.		
p. 141, t. 12, f. 21–23	Cristellaria rhomboidea Cz.	Marginuline *Cristellaria*.
" " f. 24, 25	Robulina echinata d'O.	C. calcar, var. *C. echinata* (d'O.). Limbate and longitudinally costate.
p. 142 " f. 26, 27	" stellifera Cz.	C. cultrata, subcarinate.
" " f. 28, 29	" striolata Cz.	" var. *C. striolata* Cz. Stellate umbo and longitudinal striæ.
1850. A. Alth. "Kreid. Lemberg." Haid. Nat. Abh., iii. pp. 171–284.		
p. 267, t. 13, f. 23	Cristellaria intermedia Reuss	Cristellaria crepidula (F. & M.); rather broad and keeled.
p. 268 " f. 24	" aspera A.	*Lituola*.
1850. Frederick Dixon. 'The Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex.' 4to, London.		
p. 351, pl. xxvii. f. 19	Cristellaria rotulata.	
1850. A. E. Reuss. "Foram. Oesterreich. Tertiär." Denks. Akad. Wien, i. p. 365–390.		
p. 369, t. 46, f. 15, 16	Cristellaria variabilis Rss.	Feeble C. cultrata (f. 15, elongate).
" " f. 17	" lenticula Rss.	C. rotulata.
" " f. 18	Robulina obtusa Rss.	Vorticial C. rotulata; thick variety.
1851. Harting (transl. by Schwartzkopf). 'Macht des Kleinen.'		
p. 87, f. 39, 1	Planulina turgida Ehr.	Cristellaria rotulata.
1851. A. E. Reuss. "Foss. For. Septarienthone." Zeitsch. Deutsch. Geol. Gesell., iii. pp. 49–92.		
p. 89, t. 4, f. 19	Cristellaria Juglevi Rss.	Elongate simple Cristellaria rotulata; broad C. subarcuatula.
p. 66 " f. 20	" galeata Rss.	C. rotulata (with last chamber produced and thin); poor.
p. 67 " f. 21	Robulina galeata Rss.	C. cultrata.
" " f. 22	" angustimargo Rss.	" limbate, subcompressed.
" " f. 23	" dimorpha Rss.	"
p. 68 " f. 24	" umbonata Rss.	" broadly umbonate.
" " f. 25	" nitidissima Rss.	" with straight septa.
p. 69 " f. 26	" trigonostoma Rss.	" subcarinate.
" " f. 27	" neglecta Rss.	C. rotulata, umbonate.
p. 70 " f. 28	" incompta Rss.	"
" " f. 29	" depauperata Rss. .. .	"
" " f. 30	" deformis Rss.	C. italica, large coil, subcarinate.

1851. A. E. Reuss. "Tert. Oberschlesien." Zeitsch. Deutsch. Geol. Ges., iii. pp. 149–184.

p. 153, t. 8, f. 4	Cristellaria auriformis Rss.	Elongate, compressed, subvar. of C. rotulata, with a few granules at umbilicus, and therein chiefly differing from *C. Juglevi* Rss.
" " f. 5	C. inops Rss.	Subvar. of C. italica, thick and suborbicular.
p. 154 " f. 6	Robulina angulata Rss.	C. rotulata, angular at the septa.

1851. A. E. Reuss. "Foram. Kreid. Lemberg." Haid. Nat. Abh., iv.

p. 32, t. ii. (iii.) f. 7	Cristellaria angusta Rss.	Cristellaria crepidula, narrow.
" " f. 8	" truncata Rss.	C. crepidula, ill-grown, with large umbo.
p. 33 " f. 9	" multiseptata Rss.	" with largish coil.
" " f. 10	" Spachholtzi Rss.	Cristellaria rotulata, compressed.
" " f. 11	" obvelata Rss.	C. italica, swollen.
p. 34 " f. 12	Robulina trachyomphala Rss.	C. rotulata, umbonate.

1852. T. R. Jones. Quart. Journ. Geol. Soc., viii.

p. 267, t. 16, f. 12	Cristellaria platypleura Jones	Cristellaria cultrata, with strong limbation.
" " "	" Wetherellii Jones	C. italica.

1853. J. Brown. "Artesian Well, Colchester." Annals Mag. N. H., ser. ii. vol. xii.

p. 241, pl. ix. f. 6	Cristellaria rotula	C. rotulata.

1854. J. G. Bornemann. 'Liasformation Göttingen.' 8vo, Berlin.

p. 39, t. iv. f. 27, *a, b*	Cristellaria protracta Born.	Much produced Marginuline *Cristellaria*.
p. 40 " f. 28, *a, b, c*	" Listi Born.	Produced and curved Marginuline *Cristellariæ*. Fig. 30, slightly keeled.
" " f. 29, *a–c*	" lituoides Born.	
" " f. 30, *a–c*	" spirolina Born.	
" " f. 31, *a, b*	" major Born.	Broad Marginuline *Cristellaria*.
p. 41 " f. 32, 33, 34, *a–c*	" varians Born.	Broad C. crepidula; fig. 32 being nearest to the type, and possessing a keel.
" " f. 35, *a, b*	" deformis Born.	Marginuline *Cristellaria*.
" " f. 36, *a, b*	" granulata Born.	Broad marginuline *Cristellariæ*.
p. 42 " f. 37, *a, b*	" minuta Born.	
" " f. 38, *a, b*	" convoluta Born.	
" " f. 39	" (section).	
p. 43 " f. 40, 41, *a, b*	Robulina Gottingensis Born.	Cristellaria rotulata.
" " 42, *a, b*	" nautiloides Born.	" cultrata, with weak keel.

SYNOPTICAL TABLE—*continued.*

1854. CH. G. EHRENBERG. 'Mikrogeologie.'*

t. 20, ii.	f. 24	Robulina cristellina Ehr.	Delicate Cristellaria rotulata?
„	f. 25	Cristellaria incrassata Ehr.	Strongly limbate C. cultrata.
t. 23	f. 40	Rotalia incrassata Ehr. (Planulina turgida Ehr., 1838, in part).	Small C. cultrata.
„	f. 44	Planulina? eurytheca Ehr.	
„	f. 45	Planulina hexas Ehr.	
„	f. 47	Planulina (?) umbilicata Ehr.	C. cultrata.
„	f. 48	„ (?) ampla Ehr.	
„	f. 49	„ (?) involuta Ehr.	
„	f. 50	„ (?) ampliata Ehr.	
„	f. 51	Rotalia auricula Ehr.	„ elongate.
t. 24	f. 63	Planularia thebaica Ehr.	C. italica.
t. 25, i.	f. 40	Planulina umbilicata Ehr.	C. cultrata, ill-grown.
t. 26	f. 50	„ micromphala Ehr.	C. rotulata.
„	f. 51	„ marmorata Ehr.	„
„	f. 53	Cristellaria (?) Hoffmanni Ehr.	C. cultrata, broadly keeled.
t. 27	f. 37	Nonionina (?) ocellata Ehr.	„
„	f. 46	Planulina euomphala Ehr.	„
t. 28	f. 43	„ omphalolepta Ehr. (Planulina turgida Ehr., 1838, in part).	„ feebly keeled.
„	f. 44	Planulina annulosa Ehr.	„ feeble.
„	f. 45	„ odontophœna Ehr.	„
„	f. 46	„ hexas Ehr. (Rosalina globularis (?) Ehr., 1838).	„ with small keel.
„	f. 47	Rotalia prætexta Ehr.	„ produced.
„	f. 48	Planulina adspersa Ehr.	„ vel rotulata, small. (Figs. 43–48 show various stages and conditions of growth of the common *Cristellaria* of the Chalk, in its umbilicate condition, and with more or less of a keel or crest.)
„	f. 49	„ umbilicata Ehr.	C. cultrata, limbate.
„	f. 54	Cristellaria megalomphala Ehr.	„ „

* Described by Ehrenberg in the Monatsbericht and the Abhandlungen Berlin Ak. Wiss., 1838–1842. See also Annals Mag. Nat. Hist., ser. iv. vol. ix. p. 211, &c.; vol. x. p. 184, &c. The specimens figured by Ehrenberg were of small size.

t. 28 f. 55	„ anglica Ehr.	„ „
t. 29 f. 41	Planularia tenella Ehr.	Young *Cristellaria*, which if adult "would arrive at either the Planularian or the Marginuline condition."
t. 30 f. 27	Rotalia obscura Ehr.	C. cultrata, feeble.
„ f. 31	Planulina umbilicata Ehr.	C. rotulata?
„ f. 32	Nonionina (?) spira Ehr.	C. cultrata?
„ f. 34	Cristellaria porosa Ehr.	*Planorbulina*, fragment.
„ f. 35	„ rota Ehr.	C. cultrata, limbate (= *C. planicostata* von Hagenow, 1842).
t. 32, ii. f. 10	Planularia elongata Ehr.	C. crepidula.
„ f. 36	Rotalia nonas (?) Ehr.	C. rotulata?
„ f. 37	Cristellaria alta Ehr.	C. cultrata, with large keel.
„ f. 39	Robulina (?) denaria Ehr.	C. rotulata, umbonate.
„ f. 40	Rotalia heptas Ehr.	? same as f. 36.
„ f. 47	Robulina ocellus Ehr.	C. cultrata, young.

1854. T. R. Jones, in Morris's Catal. Brit. Foss.

p. 33	Cristellaria complanata Rss.	Cristellaria crepidula var., limbate.
„	„ navicula d'Orb.	C. italica.
„	„ obsoleta Jones	C. crepidula var. Coil obsolete.
„	„ platypleura Jones	C. cultrata.
„	„ recta d'Orb.	C. crepidula, narrow and thick. Near C. subarcuatula.
„	„ rotulata (Lam.)	C. rotulata.
p. 34	„ triangularis d'Orb.	C. italica.
„	„ Wetherellii Jones	„
p. 41	Robulina calcar? (Linn.)	C. calcar.
„	„ cultrata (de Montf.)	C. cultrata.

1854. T. Rupert Jones. 'A Lecture on the Geological History of the Vicinity of Newbury, Berks,' &c. 8vo, London.

p. 11, pl. ii. f. 3	Cristellaria rotulata.

1854. A. E. Reuss. "Foram. Kreid. Ost-Alp." Denks. Akad. Wien, vii.

p. 67, t. 25, f. 10, 11	Cristellaria Gosæ Rss.	Marginuline limbate *Cristellariæ*.
p. 68 „ f. 12	„ orbicula Rss.	C. cultrata, subcarinate, umbonate, and limbate.
„ „ f. 13	„ subalata Rss.	„ umbonate and limbate.

1855. J. G. Bornemann. "Foram. Hermsdorf." Zeitsch. Deutsch. Geol. Ges., vii. pp. 307–371.

p. 327, t. 13, f. 15	Cristellaria tetraedra B.	C. italica, produced.

SYNOPTICAL TABLE—*continued.*

p. 327, t. 13, f. 16, 17	Cristellaria convergens B.	C. rotulata, arrested and produced.
p. 328 „ f. 18	„ elliptica B.	„ arrested.
„ „ f. 19, 20	„ excisa B.	C. cultrata, subcarinate.
p. 337, t. 14, f. 1–3	Robulina deformis Rss.	„ arrested.
p. 338 „ f. 4, 5	„ navis B.	„ arrested.
p. 332 „ f. 6, 7	„ angustimargo Rss.	„ compressed and limbate.
„ „ f. 8–10	„ Beyrichi B.	„
p. 337 „ f. 11	„ depauperata Rss.	C. rotulata.
p. 336 „ f. 12	„ incompta Rss.?	C. cultrata.
p. 334, t. 15, f. 1	„ radiata B.	„
p. 335 „ f. 2, 3	„ inornata d'Orb.	C. rotulata.
„ „ f. 4–6	„ limbata B.	C. cultrata.
p. 336 „ f. 7	„ limbata (?) B.	„
„ „ f. 8	„ sp.	C. italica?
„ „ f. 9, 10	„ trigonostoma Rss.	C. cultrata, subcarinate.
p. 333 „ f. 11	„ declivis B.	„ semicarinate (half *cultrata*, half *rotulata*).
p. 334 „ f. 12, 13	„ integra B.	„
„ „ f. 14–16	„ integra (?) B.	„
p. 338 „ f. 17	„ compressa B.	„ semicarinate and produced.

1855. O. G. COSTA. "Foram. Foss. d. Marna blú d. Vaticano." Mem. R. Acc. Sci. Napoli, ii.

p. 120, t. 1, f. 4	Cristellaria Volpicellii C.	Cristellaria italica, keeled.
p. 121 „ f. 5	„ contracta C.	„ „ irregular growth.
„ „ f. 7	„ obesa C.	„ subarcuatula, varieties.
„ „ f. 8	„ pulchella C.	„ subarcuatula, varieties.
p. 119 „ f. 9	Marginulina triangularis d'Orb.	„ subarcuatula, varieties.
p. 122 „ f. 10	Robulina Austriaca d'Orb.	„ rotulata, limbate.
„ „ f. 17	„ Vaticana C.	„ calcar var., few-chambered, limbate and longitudinally costulate.

1855. O. G. COSTA. "Foram. foss. d. Marne tert. di Messina." Mem. R. Acc. Sci. Napoli, ii.

Frondicularia (unilateralis).

p. 372, t. 3, f. 5	Frondicularia typica C.	Planularia rostrata d'Orb.
„ „ f. 9	„ angustata C.	„ cymba d'Orb.
„ „ f. 7	„ lanceolata C.	„ auris Defr.

„ „ f. 16	„ similis C.	„ „ narrow subvar.
„ „ f. 17	„ subfalcata C.	„ rostrata d'O.
„ „ f. 19	„ silicula C.	„ „ subvar., with straight ventral edge and costulæ.
p. 373, t. 2, f. 26	„ longiuscula C.	Planularia auris, narrow and apiculate.
„ t. 3, f. 14	„ subangulata C.	„ „ not well grown, but typical.
„ „ f. 12	„ ovata C.	(subangulata C. and ovata C.:) „ „ not well grown, but typical.
„ t. 2, f. 25	„ interrupta C.	„ „ narrow and apiculate, malformed.
„ t. 3, f. 20	„ „	„ „ without costulæ.

1855. A. E. Reuss. "Kreid. Mecklenburg." Zeitsch. D. G. Ges., vii. pp. 261–292.

p. 269, t. 8, f. 16, t. 9, f. 1, 2	Cristellaria decorata Rss.	Marginuline *Cristellaria*, bead-limbate, near Marginulina Wetherellii Jones.
p. 271, t. 9, f. 3	„ prominula Rss.	C. cultrata, limbate.
p. 272 „ f. 4	Robulina signata Rss.	„ „ and umbonate (umbo impressed with marks).
„ „ f. 5	„ megalopolitana Rss.	C. cultrata, limbate.

1855. A. E. Reuss. "Tertiärsch. nördl. u. mittl. Deutschlands." Sitzungsber. Akad. Wien, xviii.

p. 232, t. 2, f. 31, t. 3, f. 32, 33	Cristellaria gladius (Philippi)	Figs. 31, 32, 33, narrow *C. crepidulæ* or Marginuline *Cristellariæ*. } C. subarcuatula.
p. 233, t. 3, f. 34–36	„ arcuata (Phil. and Karsten)	C. crepidula, varieties, more or less limbate. } C. subarcuatula.
p. 235 „ f. 37	„ arguta Reuss	C. crepidula, limbate, with large coil. } C. subarcuatula.
„ „ f. 38	„ auricula (von M.)	Pl. auris Defr. var.
p. 236 „ f. 39	„ mirabilis Rss.	C. italica Defr., swollen.
„ „ f. 40	„ Nauckana Rss.	C. crepidula, limbate.
p. 237 „ f. 41	„ polita Rss.	C. italica Defr., rather compressed; or young C. rotulata.
„ „ f. 42	„ Landgrebeana Rss.	(polita Rss. and Landgrebeana Rss.:) C. italica Defr., rather compressed; or young C. rotulata.
„ „ f. 43	„ subcostata von Münster	C. rotulata, umbilicate and limbate.
p. 238, t. 4, f. 44, 45	„ Osnabrugensis von M.	Depressed variety of C. vortex, more or less limbate.

1856. O. G. Costa. "Atti dell' Accad. Pontaniana," vol. vii. fasc. 2, 1856.

p. 195, pl. x. f. 12	Robulina calcar (Linn.).	
p. 190 „ f. 17	Cristellaria rotulata d'Orb.	[There is no figure corresponding to this in Costa's plates.]
p. 191, pl. xiv. f. 1	„ gibbosa Costa	Elongate marginuline *C. rotulata*.
— „ f. 2	Robulina subangulosa Costa	C. rotulata.
p. 191, pl. xvi. f. 24	Cristellaria gibbosa var.	C. italica.
p. 192, pl. xvii. f. 1 and 3	„ bicornis Costa	*C. bicornis*; Fig. 1 is described as *C. coarctata* in the text.

SYNOPTICAL TABLE—*continued.*

p. 193, pl. xvii. f. 2	Cristellaria paucispina Costa	C. calcar var.
— „ f. 18	„ (monstrous).	
p. 196, pl. xix. f. 1	Robulina clypeiformis var. festonata Costa.	C. cultrata var.
p. 193 „ f. 2	Cristellaria magna Costa	C. cultrata.
p. 229 „ f. 3	Robulina inæqualis Costa	C. cultrata.
p. 198 „ f. 4	„ elegantissima Costa	C. italica, ribbed var.
p. 230 „ f. 5	„ cancellata Costa	C. cultrata.
p. 229 „ f. 6	„ inornata d'Orb.	C. rotulata.
— „ f. 7	„ semistriata Costa	C. rotulata, ribbed var.
— pl. xx. f. 14	„ lobata Costa	An angular *C. rotulata.*
— „ f. 17	„ ambigua Costa	? [A thin *Cristellaria* of doubtful specific value and affinity.]
— pl. xxvii. f. 23	Cristellaria compressa Costa	*C. compressa* d'Orb., sub-var. of *C. crepidula* (F. & M.).
1856. J. L. NEUGEBOREN. "Stichostegier von Ober-Lapugy." Denkschr. k. Ak. Wiss. Wien., xii.		
p. 103, pl. v. f. 12	Marginulina vagina Neug.	Marginuline *Cristellaria.*
1857. J. G. EGGER. "Foram. Miocän. Ortenburg." Neues Jahrbuch, 1857.		
p. 296, pl. xiv. f. 28–30	Cristellaria arcuata d'Orb.	Long Cristellaria italica.
p. 296, pl. xiv. f. 31–33	Cristellaria incerta Egger	Cylindrical three-chambered Marginuline *Cristellaria.*
„ „ f. 34, 35	„ simplex d'Orb.	Thick C. crepidula.
p. 297, pl. xv. f. 12, 13	Robulina compressa Egger	Few-chambered, swollen, umbilicate C. rotulata.
„ „ f. 14–16	„ inornata d'Orb.	14, 15. Large-chambered C. rotulata. 16. The same, keeled = C. cultrata.
1858. W. v. d. MARCK. "Diluvial-Kieses vom Hamm." Verh. Nat. Ver. Preuss. Rheinl., xv.		
p. 53, pl. i. f. 4	Cristellaria flabellinoides v. d. M.	*Cristellaria* near C. vortex.
1858. O. TERQUEM. "Mém. Foram. Lias"—Première Partie. Mém. Ac. Imp. Metz., t. xxxix.		
p. 619, pl. iii. f. 14	Cristellaria matutina (d'Orb.)	Marginuline C. rotulata, much produced.
p. 620 „ f. 15	„ antiquata (d'Orb.)	
p. 621 „ f. 16	„ prima d'Orb.	Thin C. cultrata.
p. 622 „ f. 17	„ vetusta d'Orb.	Marginuline C. rotulata, much produced.
„ „ f. 18	„ Terquemi d'Orb.	A Planularian C. crepidula, partly keeled.
p. 623 „ f. 19	„ rustica d'Orb.	C. rotulata.
„ pl. iv. f. 1	„ ornata Terq.	A *Planularia.*
p. 624 „ f. 2	„ speciosa Terq.	A *Marginulina.*
p. 625 „ f. 3	„ geniculata Terq.	Deformed *Planularia.*

„ „ f. 4	„ incisa Terq.	Thin umbilicate C. rotulata.
p. 619 „ f. 5	„ matutina d'Orb.	Deformed *Planularia.*
p. 627 „ f. 6	Robulina metensis Terq.	C. rotulata.
1858. W. C. Williamson. "Recent Brit. Foram."		
p. 25, t. 2, f. 52, 53	Cristellaria calcar (L.)	C. cultrata.
28, „ f. 54	„ „ var. rotifera W.	Flat (?) strongly and equally limbate.
„ „ f. 55	„ „ „ oblonga W.	Thick and keeled *Planularia*, with branching costulæ.
29, „ f. 56–59	„ subarcuatula (W. & J.)	Fig. 56, *C. Berthelotiana* d'O. Fig. 57, *Marginulina glabra* d'O., Model 3. Figs. 58, 59, Cristellaria crepidula.
31, „ f. 63–67	„ „ var. costata W.	Fig. 63, *Marginulina raphanus* (L.). Figs. 64–66, *Vaginulina Dunkeri* Koch. Fig. 67, *Vag. harpa* Römer, var. [Jurassic.]
30, „ f. 60, 61	„ „ „ scapha W.	Extremely elongated C. italica.
96, „ f. 62	„ „ „ elongata W.	Elongated *Cristellaria lævigata* d'O.
1859. Thomas Wiltshire. "On the Red Chalk of England." Geol. Assoc. 8vo, London.		
p. 15, pl. ii. f. 8	Cristellaria rotulata.	
1860. J. G. Bornemann. "Foram. Tertiär. Magdeburg." Zeitsch. Deutsch. Geol. Ges., xii.		
p. 156, pl. vi. f. 1	Robulina Cumingii Michelotti	Thick-keeled C. cultrata.
p. 157 „ f. 2	„ Magdeburgica Born.	Thick-ribbed and thick-keeled C. cultrata.
1860. T. Rupert Jones and W. K. Parker. "Chellaston Foram." Q. J. Geol. Soc., xvi.		
p. 453, pl. xx. f. 38	Planularia reticulata Cornuel	
p. 454 „ f. 39	Planularia pauperata J. & P.	A thick and dwarf C. crepidula.
„ „ f. 40	„ Bronni Roem.	A Marginuline form; a thick C. subarcuatula.
p. 453 „ f. 41	Cristellaria cassis F. & M.	C. cultrata.
„ „ f. 42, 43	„ rotulata Lam.	C. cultrata.
1860. A. E. Reuss. "Foram. Westphälischen Kreide." Sitz. k. Ak. Wiss. Wien, xl.		
p. 212, pl. viii. f. 6	Cristellaria inflata Reuss	Swollen Marginuline *Cristellaria.*
p. 215 „ f. 7	„ microptera Reuss	Umbilicate C. cultrata.
p. 213 „ f. 8	„ oligostegia Reuss	Few-chambered inflated C. rotulata.
p. 212, pl. ix. f. 4	„ Marcki Reuss	Compressed Marginuline and umbonate *Cristellaria.*
p. 211 „ f. 5	„ tripleura Reuss	Subcylindrical Marginuline *Cristellaria.*
p. 210 „ f. 6	„ Hagenowi Reuss	Thickish Marginuline *Cristellaria.*
p. 214 „ f. 7	„ secans Reuss	C. rotulata.
p. 211, pl. x. f. 1, 2	„ harpa Reuss	Varieties of C. crepidula.
p. 213 „ f. 3	„ acuta Reuss	Variety between umbonate C. rotulata and C. cultrata.
p. 210 „ f. 4	„ inepta Reuss	Swollen marginuline *Cristellaria.*

XI.—*On new species of Scyphidia and Dinophysis.*

By J. G. Grenfell, F.G.S.

(*Read 8th June*, 1887.)

Plate XI.

Last September I came across an exceedingly interesting new species of *Scyphidia* living parasitically on the tails of some sticklebacks in Dorsetshire. From its habit I propose to call it *Scyphidia amœbæa.* I have not yet found it on the sticklebacks near Bristol. The points of special interest are two: first, the mode of attachment, and secondly the process of reproduction, which has hitherto been unknown in any species of this genus. Sometimes the animal is simply attached by the posterior end of the body in the ordinary way, without there being anything to draw special attention to this part; as in plate XI. fig. 1, 2; or again the base may be widened out, as in fig. 4. But in the great majority of cases, the animal is attached by means of pseudopodia, as in figs. 5–10. These may take the form of a single lobe or of two simple lobes, and so on up to several large highly complicated processes. I found it hard to draw these accurately from the living animal, because the stickleback's tail interfered with the light; but by killing with salicylic acid and staining I obtained a number of good specimens free. On the living animal I sometimes found that the lobes of the pseudopodia ended in threads, but these are not visible in preserved specimens.

I do not know of a parallel case among the Peritricha; but among the Holotricha *Stentor Roeselii* sometimes has pseudopodic projections round the base, according to Simroth, but much smaller and less complicated ones than in the present case.

The integument of this species is highly elastic, as in the rest of the genus, and the animal consequently assumes a variety of forms, as may be seen in the figures. On the whole, however, the body is conical, increasing in width from the base upwards. The surface of the integument sometimes seemed highly granular in living specimens.

The body is generally divided into two distinct portions; the upper half is very coarsely granular; it contains the contractile vesicle in its upper portion; the lower half of the body is nearly always very much clearer; in its upper part lies the very large granular nucleus which is always a very conspicuous object, is broadly egg-shaped, or sub-triangular, and occasionally I have seen this divided into two parts. The peristome is well developed.

I met with one live specimen in the act of dividing by transverse fission. This is shown in fig. 14. A well-marked constriction had been formed, and the new ciliary wreath was in active motion all round. I did not trace the process further than this, but I think there can be no

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EXPLANATION OF PLATE XI.

Fig. 1–6.—*Scyphidia amœbæa* from the living animal.
„ 7–10, from preserved specimens.
„ 11.—*Scyphidia amœbæa* dividing; from the living animal.
„ 12.—*Dinophysis semicarinata.*

doubt as to what was going on. This is the first record of the mode of reproduction in the genus.

I was not aware that any theoretical importance attached to this observation till on my return home, I obtained Prof. Bütschli's very ingenious and interesting paper on the relationship of the Vorticellina to the other Ciliata. In this paper Prof. Bütschli limits the Vorticellina to Stein's three families of Vorticellina, Ophrydina, and Urceolarina. He points out that in the Vorticellina the adoral wreath of cilia forms a right-handed spiral, while in *Stentor* and other Ciliata the spiral is left-handed. He also recalls the fact that in the Vorticellina division is longitudinal instead of transverse, and shows how both these peculiarities can be explained by supposing the Vorticellina to be derived from some such form as *Lichnophora.* By a change in the orientation of the Vorticellid body the adoral wreath becomes the dorsal surface, the point of attachment to the stalk is the ventral surface, and their division is once more transverse.

But Saville Kent has shown that *Ophrydium Eichornii* frequently divides by longitudinal fission, and here is *Scyphidia*, a genus placed very close to *Vorticella,* also dividing transversely.

If this proves to be the normal method of division in the genus, and if Prof. Bütschli's theory is to stand, it would seem that *Scyphidia* must be relegated elsewhere, to near *Spirochona* probably. I do not think this a satisfactory solution of the difficulty.

But what is to be done with *Ophrydium?* This genus divides *both* ways, which if hereditary would imply a longitudinal division, as well as a transverse one, in its ancestors among the Ciliata of the *Licnophora* type. Is not that impossible? or is the direction of fission determined in some cases by the shape of the animal? As the other Ciliata are in the habit of dividing longitudinally after conjugation, and have the power of reproducing any part of their body, is it impossible to suppose that the same cause which originally made the elongated Ciliata divide transversely may also act in making the elongated Vorticellina divide transversely to their length? If this were possible, *Ophrydium* would be a connecting link between *Scyphidia* and the Vorticellina in respect to reproduction. The length of this species is about 0·00275 in. for a good sized specimen, and the width about half the length. This or a closely allied species is also found on the loach.

From a surface gathering in Port Royal Harbour, Jamaica, I obtained the species of *Dinophysis* shown in fig. 15. It was common and the only species present. Of the species figured in Stein's great work it most resembles *D. Homunculus;* but the position of the projecting foot, which instead of being on the axis of the body lies in a line with the ventral edge of the rest of the body, together with the keel-like ridge on the back, distinguish it at once from Stein's species.

Saville Kent has described, but not figured, a species, *D. caudata,* which in some respects is very like this one. The chief points of difference are as follows:—

1. In *D. caudata* the body is said to be "inflated," and is compared in shape with the body of *D. norvegica* and *D. acuminata,* which are distinctly rounded in outline. The new species is not rounded at all.

2. *D. caudata* is described as having a smooth ridge or keel running along the dorsal surface of the broad part of the body, apparently along its whole length. The new species has this ridge confined to the distal half of the broad part.

3. No reference is made to the small knobs at the end of the foot, one or more of which are always present in the new species.

In various other points the language is hardly that which would naturally be used in describing the Port Royal species, but the above are, I think, sufficient.

Description of the new species. The body expands posteriorly, and terminates in a large foot-like prominence, the ventral edge of which is in a line with the ventral edge of the rest of the body. This terminates in one, two, or three, small knobs, or prominences. A smooth keel-like ridge runs along the posterior half of the dorsal edge of the wide part of the body. The funnel at the head is very large, larger, I think, than in any other species. It is very nearly equal to the whole width of the body. Its surface is wrinkled, not finely striated as in Saville Kent's species. The collar, round the neck, posterior to this, is very delicate and difficult to see; but its dorsal extremity is strengthened by a thick and long projection of the cuirass. This projection is also characteristic of the species. The ventral plates are three or four in number, the fourth one being a small posterior one, as figured. The first of these seems to be attached to the right valve of the cuirass, and the second to the left valve. This latter plate is frequently more or less veined with a network of approximately circular meshes. The cuirass is extremely thick and is pierced with many holes, which at the level of the surface are large, and form a complete network; at a lower level they terminate almost in a point.

From its half keel I propose to call it *D. semicarinata*. Length 0·0036 in.; breadth of body 0·0016 in.; breadth, including ventral plates, 0·0022 in.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Continuity of Germinal Protoplasm.‡—Dr. W. Richter discusses the various factors in organic evolution with special reference to Weismann's conclusions. The greater portion of his paper covers very familiar ground, but the degree of misunderstanding between Virchow and Weismann is lucidly and carefully explained. In the latter part of his paper the author takes as a special case the variations which he has observed in the connective tissue of human subjects. A list of these is given. The same variations occur independently of local inheritance, in mechanical response to functional demands. The local modification cannot be said to be directly inherited, but is the result of an associated quality of connective tissue expressing itself through a definite law of growth. The relation of Weismann's conclusions to psychology is finally discussed. Their essential consistency with the main propositions of the natural selection theory is maintained throughout.

Development of the Carnivora.§—Dr. A. Fleischmann has carried out some interesting investigations upon the development of the Carnivora, on which he reports as follows:—

Material was hard to obtain, in spite of the fact that cats and dogs are to be found as pets in every family. From one hundred to one hundred and fifty cats were examined weekly during the rutting periods in February and June. Later it was found possible to obtain materials from animals kept in confinement. Besides this, useful material was obtained through sportsmen from foxes and wild cats.

A series of stages of the domestic cat was obtained by the successive extirpation of the horns of the uterus. The preservative fluid was picro-sulphuric acid, to which one-tenth per cent. of chromic acid had been added.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Biol. Centralbl., vi. (1887) pp. 40–50, 67–80, 97–108.

§ Ibid., vii. (1887) pp. 9–12. Cf. Amer. Natural., xxi. (1887) pp. 394–6.

The author has not yet been able, in spite of great care and patience, to find the ova of the cat and dog in process of segmentation in the oviducts. The youngest ovum which he found was a somewhat oval blastosphere, upon which the germinal area was already very distinct. This was invested by a very distinct Rauber's layer of cells.

The youngest blastosphere of the cat is nearly spherical, and twelve days after the first copulation still presents the form of an oblong sphere. Through rapid growth at the poles, it soon, however, becomes citron-shaped; the germinal area then forms a convex elevation on the middle third of the blastosphere.

While the blastosphere of the dog retains the two-pointed, citron-shaped form, that of the cat retains that form for only a very short time, and becomes barrel-shaped, in that the points of the blastosphere are pressed inward by mutual pressure in the successive sections of the uterine cornua, so that the ends of the growing blastospheres are only feebly conical. The flattened extremities of the blastosphere are not undergrown by mesoderm, and therefore no vessels are developed in that portion of them. At the outer margins of the flattened ends of the barrel-shaped ovum, there is a delicate reticulum formed of elevations of the ectoderm, which has apparently arisen by pressure of the ends of the hollow ovum upon the folds of the uterine mucous membrane.

Around the entire germinal area and at the opposite side of the blastosphere, on the twelfth day, there are already formed small projections and elevations of the ectoderm, which serve to attach the ovum to its nidus. Before the allantois has reached any considerable dimensions, the subzonal membrane has thrust out villi in all directions, and into these grows the connective tissue supporting the outer vascular layer of the allantoic sac.

The primitive groove is formed in the germinal area at right angles to the long axis of the blastosphere; the same direction is assumed by the medullary groove. At about the sixteenth day the entire germinal area changes the direction of its axis to one parallel with that of the axis of the ovum, a condition which the embryo maintains until birth.

In the primitive streak the mesoderm is formed exclusively from the outer walls of the primitive groove; in many sections one sees the mesoderm proliferating outward from the sides of the primitive streak between the two primary embryonic layers, and numerous cleavage figures indicate rapid growth in this region. The entoderm is always distinctly marked off from the mesoderm, and the author could not obtain clear proof of the entoblastic origin of the mesoderm. Even at the anterior end of the medullary groove the mesoderm is always sharply marked off from the other layers; a heaping up of the mesoderm on the entoderm as described by E. van Beneden is not apparent.

The mesoderm is characterized in well-preserved germinal areas, from eleven to thirteen days old, as a solid mass of cells, which is composed of several layers of cells under the germinal area, but consisting, outside of the latter, of but a single layer of cells.

The cœlom first appears as clefts in the mesoblast outside of the germinal area, and is pushed in under the latter at a later period.

A chordal canal is always developed, and opens at a number of points into the cavity of the umbilical vesicle or yelk-sac; an opening of this canal into the anterior end of the primitive streak was not discovered. Only in an advanced embryo, with ten somites, could a slight ectodermal depression be discovered at the anterior end of the primitive streak, but this was closed below by a mass of cells.

In front of the medullary groove lies a completely closed mass of mesoblast; the interamniotic pore, described by E. van Beneden and Julin, was not observed in young germinal areas.

The anterior amniotic fold in the cat, dog, fox, and mole is not covered by mesoderm, but consists wholly of ectoderm and entoderm. It follows from this that there is found a proamnion not only in Rodents, Bats, and Marsupials, but also in Carnivora and Insectivora, from which it may be concluded that it is a structure common to the Mammalia. The significance attached to it by Van Beneden the author cannot share.

The Wolffian duct does not arise as a solid cord of cells, but, as the author observed in the duck, as a diverticulum of the cœlom; that the ectoderm takes part in the formation of the Wolffian duct was not established.

As respects the formation of the maternal placenta, the author fully confirms the statements of Bischoff, that the villi of the chorion grow into the uterine glands, destroying the latter.

Embryology of Monotremata and Marsupialia.*—Mr. W. H. Caldwell has published an abstract of the first part of his paper on the development of Monotremata and Marsupialia. In very young ova of the former there is a fine membrane between the single row of follicular cells and the substance of the ovum; this vitelline membrane at first increases in thickness with the growth of the ovum, and numerous fine protoplasmic processes pass through it and connect the protoplasm of the follicular cells with that of the ovum; these serve for a time to conduct food granules. This "yolk-forming period" is succeeded by an "absorption of fluid period," during which the ovum absorbs large quantities of fluid, and increases in size; the third period is that of the formation of the chorion. All these periods are gone through while the egg is still in the follicle. In the passage of the egg along the Fallopian tube the vitelline membrane again increases in thickness, and the chorion absorbs fluid and becomes the albumen layer; outside this now appears the shell or shell-membrane, which is tough and parchment-like, without calcic salts in *Echidna*, but apparently with them in *Ornithorhynchus*. The deposition of the shell has not yet been observed to be due to the activity of any special glands, but the author says the shell-membrane does not increase at the expense of the chorion or albumen layer. In Marsupials the yolk-forming period is not marked off from the absorption of fluid period; in an ovum of *Phascolarctos* there was a thin transparent shell-membrane.

The ova are telolecithal, and go through a partial segmentation; though the ova of Placentalia segment completely, the resulting blastodermic vesicle is identical with that of Monotremes and Marsupials. A primitive streak region is formed, in Monotremes, in front of the posterior lip to the blastopore, and long before the epiblast has enclosed the yolk. In Marsupials the epiblastic growth encloses the hypoblast at a very early stage, except over a narrow slit in front of the posterior lip of the blastopore; the primitive streak is not conspicuous at an early age, because of the large size of the cells. Balfour's objection to the comparison of the blastopore of the rabbit with that of the frog is explained by the presence of a posterior lip to the blastopore in Marsupials; the author postulates the existence of a similar structure in the rabbit, and regards its blastopore as corresponding to the whole area marked out by the growing epiblast and the posterior lip of the blastopore before the closing of the primitive streak region.

* Proc. Roy. Soc. Lond., xlii. (1887) pp. 177–80.

Wall of Yolk-sac, and Parablast of the Lizard.*—Dr. H. Strahl finds that the yolk sac of reptiles presents many resemblances to that of birds; the yolk-sac is at no period a vesicle equally thick in all its parts and composed of two simple layers; the mode of growth of the endoblast appears to be peculiar, for it does not widen out as a special epithelial membrane, but its cells are found around the yolk.

In agreement with Kupffer, the term parablastic is applied to the cells which lie beneath the endoblast, after the development of the three germinal layers; their parablastic cells may be seen even during the cleavage period, when they are formed by a tranverse division of the germ; and the defined masses of yolk-spheres may be seen in all further stages; they lie partly between the cords of vessels or endoblast-cells, which form the lower thick wall of the yolk-sac, and partly at its free edge; it has not yet been definitely shown that they contain cell-nuclei. In the later stages of development free cells may be distinctly seen within the yolk-sac; these are sometimes very numerous; the cells are small, and have a distinct nucleus; they are irregularly scattered in the yolk-sac, and look as though they were lymphoid cells. It is possible that some of the parablast-cells take a part in the formation of the endoblast, but this point cannot be yet definitely settled; there is no reason to suppose that the cells arise or multiply by free-cell formation. The author discusses in detail the supposition of Kollmann that the germinal ridge (marginal ridge, Kollmann) is the seat of origin of the blood; and he comes to the conclusion that there is no reason for accepting this hypothesis, or that a zone separated off from the mesoblast gives rise to the blood-vessels. What Kölliker has shown to be true of Birds and Mammals seems to hold also for Reptiles.

Maturation and Fertilization of Amphibian Ova.†—Dr. O. Schultze has been led by his studies on the ova of Amphibians to some general results; he finds, as do those who have investigated the ova of other classes of animals, that the germinal vesicle shares the fate of all the parts that do not form the directive corpuscles, and passes into the substance of the egg-cell; greater weight must henceforward be laid on the fact that there is a complete intermixture of the female nuclear substance and the cell substance before fertilization. The nuclear substance which is collected around the germinal vesicle as it commences its retrograde metamorphosis is sharply separated, in some cases even by a temporary membranous layer, from admixture with the substances of the egg. After a time this separation ceases, and the two parts soon unite. A part of the chromatic substance passes to the surface of the egg, and then by a double mitotic division gives rise to polar bodies; in the unripe egg of the Amphibia the germinal vesicle occupies a central position so long as its fluid substances are equally grouped in the direction of all the rays; yolk-gemmules, which are quite distinct, soon collect, and increase in size; the egg then becomes telolecithal. Objection is taken to van Beneden's epithet of "pseudo" as applied to the karyokinesis which obtains in the egg of *Ascaris megalocephala;* and the author concludes with enumerating the proved cases of the presence of polar globules in vertebrates.

Structure of Ovum of Dipnoi.‡—Mr. F. E. Beddard has a further contribution to our knowledge of the structure of the ovum in *Protopterus*, and some notes on the ovary of *Ceratodus;* in the latter form the multicellular

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 282–307 (1 pl.).
† Ibid., pp. 177–226 (3 pls.).
‡ Proc. Zool. Soc. Lond., 1886 (1887) pp. 505–26 (3 pls.).

or plasmodial ova, which are sufficiently common in the former, are much more rare than the ordinary unicellular ova. Mr. Beddard points out that the fact of there being two kinds of ova with a different mode of development is not new to the Vertebrata, as the "egg-nests" of Elasmobranchs suffice to show; and these egg-nests are common among Vertebrates. In all these, however, both kinds of eggs have morphologically the value of a single cell. The important facts to be borne in mind in comparing the egg-nests of Elasmobranchs with the ova of Dipnoi appear to be the early formation of the complicated follicular layers in the latter and the early commencement of yolk-secretion; the temporary fusion of the primitive ova in the Elasmobranchii, and the degeneration of some of them becomes permanent in the Dipnoi, the ovum being the equivalent of a whole nest. The apparent absence of any protoplasm in the yolk-mass of these remarkable structures in the Dipnoi renders it extremely unlikely that the structure developes into an embryo. The formation of ova as described by Prof. Huxley in *Lacinularia* appears to be clearly analogous to the fusion of a number of germinal cells in *Protopterus* and *Ceratodus*.

Vesicle of Balbiani.*—M. L. F. Henneguy has been studying sections of ovaries of young guinea-pigs and rats, fixed immediately after death by Flemming's mixture of chromic, acetic, and osmic acids; in the young ovules he always found a slightly refractive body with well-marked contours, placed near the germinal vesicle. This—the vesicle of Balbiani—is found in young primordial ova, but is not found in such as are more advanced; its coloration is uniform, its substance chromatophilous, and not arranged in a plexus as in the nuclei. The author enumerates the various forms in which he has succeeded in finding it, and then passes to the very interesting observation that his studies on the testicle of the rat has shown him that the so-called accessory nucleus which has been recently studied by Nussbaum and Platner, ought to be regarded as comparable to the vesicle of Balbiani in ova.

The only reagent which, at present, is found to be useful in fixing this vesicle is that of Flemming.

Atavism.†—Mr. J. Bland Sutton tries to show that, using the classification of Prof. Gegenbaur, all examples of atavism are palæogenetic, and that none are neogenetic, or not found as a germ in the embryo; the prostate is selected as affording a remarkable instance of atavism, and it is regarded by Mr. Sutton as a suppressed uterus, the fibro-muscular tissue representing the matricial walls, the follicles corresponding to the reticular glands, and the reticulus itself being identical with the cervix uteri and the immediate adjacent portion of the vagina. It seems to be clear that the prostatic concretions and egg-shells agree structurally and chemically and are produced by homologous organs, so that man has in his prostate an unimpeachable witness of an ancestry with the feathered tribes low down among the oviparous reptiles.

Dealing with secondary sexual characters, the author urges that the known facts seem to point to the conclusion that the epiblast is chiefly derived from the male element, while the female pronucleus is chiefly responsible for the hypo- and greater portion of the mesoblast; if this be true, the transmission of characters peculiar to the male is not so obscure as many have supposed.

* Sep. Rep. Bull. Soc. Philomath. Paris, 1887, 4 pp.
† Proc. Zool. Soc. Lond., 1886 (1887) pp. 551–8.

β. Histology.*

Karyokinesis.†—Prof. W. Waldeyer gives a useful historical résumé, with interpolated criticisms, of recent researches on cell-division, with accompanying diagrams and bibliography.

Cup-shaped Cells.‡—M. L. Ranvier discusses the vacuoles of cup-shaped cells, the movements of the vacuoles and the intimate phenomena of the secretion of mucus, taking as his object of investigation the cells found in the epithelial covering of the membrane which invests the retro-lingual lymphatic sac of the edible or the grass-frog. In answer to the question, Is the vacuolar movement a vital one? M. Ranvier finds that it ceases on the death of the cells. After staining, it is possible to see that the vacuoles are situated in the mass of protoplasm which occupies the base of the cell, or in the protoplasmic processes which are given off from it, and they may, therefore, be found in any region of the cup-shaped cell from its base to its orifice. When the cells are examined in the living state it may be noticed that some of the vacuoles which they contain disappear more or less rapidly and before reaching the surface of the mucous membrane. It is probable that, breaking within the cell, they pour out, along the lines of protoplasmic substance, the liquid which they contain, and that this liquid, bathing the masses of mucigen, carries away part of it. Thus charged with mucin it arrives at the surface converted into mucus.

Giant Cells of Tubercle.§—Herr A. Obrzut concludes, from his observations, that a giant tubercular cell does not represent a histological unit, but in reality a conglomeration of endo- or epithelial cells hypertrophied by the influence of the parasites of the tuberculosis, and that it is, as usually observed, in process of undergoing retrogressive modifications.

Alteration of the Red Blood-corpuscles.‖—In normal blood Sig. A. Mosso finds corpuscles which become altered with the greatest ease, while others are more resistant. It is impossible to examine microscopically the blood of most animals without destroying or profoundly altering a certain number of corpuscles. Mere contact with glass suffices to quite decolorize, alter their shape, and bring the nucleus into view. In the red corpuscle can be distinguished a skeleton or network, which is brought out by maceration and digestion. By digesting the blood of various animals, especially birds, in gastric juice, a red corpuscle is seen to be composed of an external envelope, of a granular fibrillar network, and of a nuclear sac. Within the nuclear sac are usually seen ten to twelve corpuscles, which stain more deeply than the nucleus. Between the external envelope and the nucleus may be distinguished, even in mammals, a median zone, which the author calls the cortical part. It is composed of two substances so intimately commingled that they form a homogeneous substance in the physiological condition, but which separate on alteration of the corpuscle, and then the one looks transparent and the other yellow from hæmoglobin. Sig. Mosso has seen crystals within the corpuscles of dog's blood, coagulated slowly or rendered incoagulable by the addition of pancreatine. These crystals are rhomboidal, with well-marked angles, and yellow in colour, and concentric in position. The diameter of the corpuscles being about 6 or 7 μ, the crystals measure $2 \cdot 5\ \mu$ to $5\ \mu$. The resemblance of these crystals to

* This section is limited to papers relating to Cells and Fibres.
† Arch. f. Anat. u. Physiol., 1887, pp. 1–30.
‡ Comptes Rendus, civ. (1887) pp. 819–22.
§ Arch. Slav. Biol., ii. (1886) pp. 402–25 (1 pl.).
‖ Atti R. Accad. Lincei.—Rend., iii. (1887) pp. 252–7.

hæmoglobin shows that in the higher vertebrates there exists within the corpuscle a substance analogous to albuminoid bodies, and which is able to crystallize without the corpuscular form changing. The corpuscle is decolorized because the yellow substance separates from the other which is found in the cortical portion, and crystallizes without leaving a trace of the nucleus.

The normal form of the mammalian red corpuscle is not that of a biconcave disc, as is usually believed, but this appearance is produced by alteration of structure due to unsuitable conditions, mechanical violence, chemical reagents, and the like. In his experiments Sig. Mosso used very dilute solutions (sodium chloride 0·75 per cent., stained with methyl-violet 1 in 5000), alkaline eosin 1–2 per cent., NaCl 0·6 per cent., or methyl-green 1 per cent. Except blood-serum, all other fluids were found to alter more or less rapidly the red corpuscles, but contact with glass is stated to be extremely damaging. For example, if a drop of blood squeezed out of a pigeon's feather be treated with 2 per cent. eosin solution, and viewed without contact, the nucleus will be found unstained. But if the same drop be but lightly touched with a cover-glass, the corpuscles become altered, the nuclei become red and swollen, the cortical part more pallid, as if the hæmoglobin had disappeared. This great susceptibility of change Sig. Mosso considers to have been the cause of many errors, and these of such magnitude that it is necessary to repeat the whole course of the histology of the blood, for every ordinary method of examining blood destroys the cortical part of the corpuscle.

Sig. Mosso concludes by alluding to the differences in the resistance of red corpuscles. This resistance was measured roughly by means of 0·3 per cent. chloride of sodium solution, stained with methyl-violet 1 : 5000, and more accurately by successive strengths of the chloride solution (0·76–0·4 per cent.). These experiments are not yet fully completed, but it may be stated that the resistance for any given species is very variable, and that the corpuscles of birds are the most resistant.

Nuclei of Striated Muscle-fibre in Necturus (Menobranchus) lateralis.*—Mr. A. B. Macallum has obtained his best preparations of the nuclei of *Necturus lateralis* with gold chloride and formic acid; many of the isolated nuclei have on their surface furrows and striations; the former are probably due to the pressure exercised by the trabeculæ of the muscular reticulum; this last appears to the author to be the true contractile element, while the myosin shifts and accommodates itself. In some cases the reticulum was not on, but in the nucleus, and in these cases no chromatin or caryoplasma could be discovered. Mr. Macallum thinks with Carnoy and Melland that the muscle reticulum is simply the modified cytoplasma, the caryoplasma being derived from the latter. When the caryoplasma is modified as in some of the cells observed, the nuclei must be capable of movement, or of contraction and extension; the possession of a square-meshed reticulum implies extension and contraction in definite directions—the nucleus contracts with the muscle-fibre and extends with it again, yet not passively. Where nuclei have part of their surface completely free from furrows, we may suppose that part only of the nuclear body is surrounded by the muscle substance, a part of it lying between the latter and the sarcolemma.

Variations in Wool.†—Dr. F. H. Bowman gives an interesting account of variations observed in the structure of wool and other fibres. These indicate a constant tendency to a reversion to a more primitive type, besides illustrating the effects produced by the environment or by artificial selection

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 461–6 (1 pl.).
† Proc. Roy. Soc. Edin., 1887, pp. 657–72 (1 pl.).

in breeding. He defines the difference in degree between hair and wool, as expressed in the method of attachment of the epidermal scales which form the external covering of the fibres. The modifications which are noted concern all the various parts of which the hair is composed. In the fleece of the semi-wild sheep of Central Asia, three different classes of fibres may be distinguished often in the same lock of wool; (*a*) those which have all the characteristics of true hair in their most marked degree; (*b*) those which resemble alpaca and mohair fibres; (*c*) those which are true wool. "All the variations observed are formed in the fibres from the same sheep in the various races which inhabit Central Asia, while in most of the sheep inhabiting other parts of the world the usual variations from the normal types are less distinctive in their character and confined within narrower limits. This seems to point to the mountainous regions of Central Asia as the district from which the present domestic sheep has spread.

B. INVERTEBRATA.

Vitality of Encapsuled Organisms.*—Herr M. Nussbaum noticed a living embryo in a *Daphnia* which had been expelled from the gastric cavity of *Hydra;* of this *Daphnia*, as of another that was swallowed, nothing remained of the soft parts. This observation showed that the embryos of the Cladocera that were seized were not killed by the poison of the stinging organs, and that the egg-shell protected them from the "digestive ferment of the Polyps." An experiment with absolute alcohol used to poison a pregnant female *Daphnia* showed that while the adult was killed the young remained capable of further development when transferred to pure water. Considering the enormous voracity of *Hydræ* this immunity of the *Daphnia* embryos is important, not only for the latter but also for the polyps. The resistance of the embryos being due to the presence of a hard egg-shell, the whole phenomenon is comparable to the power possessed by many lower organisms of forming a temporary capsule to protect themselves against desiccation; and in the plant-world there are other analogies—fruits serve as food for animals, but their seeds pass uninjured through the digestive tract.

Influence of Medium.†—M. A. de Varigny has made a number of experiments as to the effect of alterations of medium on *Beroe ovata*, *Aurelia aurita*, and Pagurids. Some of these may be thus summarized:—

Beroe	Fresh water	Contraction and death.
"	Equal parts fresh and salt	Contraction, with recovery after replacement in salt water after 15 mins.
"	1 part fresh to 3 salt	Same effect.
"	" " 5 salt	No effect.
"	Sea-water at 31°	More rapid movement of ciliated plates.
Aurelia	" "	Rhythmic movements replaced by rapid and spasmodic, but normal again in 11 mins.
Beroe	" at 35°	Spasms; normal again in 25 mins.
"	" at 40°	Death.
"	" + 2 per cent. sulphate of copper	Rapid death.
"	" + 1 " bichromate of potassium	Reduction of ciliation and contraction and slow death.
"	" + 1·5 per cent. chloral hydrate	Slow death.

* Zool. Anzeig., x. (1887) pp. 173–4.
† Soc. de Biol., 1887. Cf. Biol. Centralbl., vii. (1887) pp. 127–8.

Mollusca.

Shells of Cephalopoda.*—Herr E. Riefstahl, after pointing out the different relations held to their shells by Cephalopoda and Gastropoda, distinguishes the external shells of the Ammonites and recent Nautiloids from the internal shells of Belemnites and Squids. The great differences between shells depend on various modes of life; those of the Ammonites were almost more important as swimming organs than as defensive envelopes, for they were generally very thin and light, much lighter than those of the existing *Nautilus*; the shells of Belemnites were very strong, and gave the whole body great powers of resistance; they were enclosed by a thick skin rich in vessels, so that if they were injured they were rapidly healed. The *Sepiæ* have a light shell, which is, however, fairly strong. With regard to the formation of the septa, the author remarks that every septum arises from its predecessor, becomes separated from it by the increase in length of the intervening walls, and finally becomes a new strong septum; in consequence of this the hinder end of the body of the animal is always in contact with a septum, and does not need to secrete either air or chalk. There is good reason for ascribing to the Cephalopod-shell the independent mode of growth which has been detected in the Lamellibranchiata, and there is no reason for supposing that there is any secretion from the body of the animal.

Renal Organs of Prosobranchs.†—Herr G. Wolff gives a preliminary notice of his observations on the renal organs of German Prosobranch Mollusca, *Paludina vivipara*, *Bithynia tentaculata*, and *Valvata piscinalis* having been examined. He has been able to convince himself of the presence in all these of the internal orifice; the great reduction which this has suffered, greater even than in the Pulmonata, will explain Leydig's failure to find it in *Paludina;* it is least reduced in *Valvata*, where its duct has long and strong cilia. In *Paludina* the pericardial opening of the kidney is clearly in physiological connection with the opening of the kidney into the water-reservoir, for the muscular fibres which inclose the former are connected with the sphincter which embraces the latter. In *Bithynia* a glandular body which corresponds to the kidney of *Paludina* projects freely into the organ which may be regarded as the water-reservoir; it differs from *Paludina* in having two orifices, one upper and one lower, which lead to the exterior; the pericardial orifice is quite close to the former of these.

Glands in Foot of Tethys fimbriata.‡—Dr. J. H. List finds considerable differences in the presence of glands on the upper and lower sides of the foot of *Tethys fimbriata;* on the former there are unicellular mucous glands, unicellular glands with specially formed fat-like contents, which may possibly be phosphorescent organs, unicellular glands with special contents, some of which are often arranged in a lamellar manner, and similar glands which have coarsely granulated contents. Of the numerous glands there are two kinds; in one the form of the gland is flask-like, and these are bounded by a distinct membrane and contain two different masses, which are arranged as in the goblet-cells; there is a filar mass arranged in a meshwork, and an interfilar mass. The second form of unicellular mucous glands are quite like goblet-cells, even if they are not, as the author believes, epithelial elements. The glands, which may have a phosphorescent

* Naturforscher, xx. (1887) pp. 153–4, from Palæontographica, xxxii. (1886).
† Zool. Anzeig., x. (1887) p. 317.
‡ Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 308–26 (1 pl.).

function, are very largely developed, not only over the whole of the foot, but on other parts of the body; the contents are almost completely homogeneous and are of a fatty nature; it is to be noted that Grube has reported that *Tethys* is remarkable for its strong phosphorescence, and Panceri has remarked that the unicellular glands which serve as the luminous organ of Annelids have fatty contents.

In another form of gland lamellæ are found, some of which exhibit a concentric arrangement, but this may be due to the mode of hardening; the function of these glands is not quite clear, but it is certain that they are not mucous organs, though it is possible that they are byssus glands, the contents of which have been altered in the process of preparation. The glands with coarsely granular contents are pyriform in shape; their function is unknown.

On the lower side of the foot there are, in addition to the goblet-cells, a few small mucous glands, a comparatively small number of luminous organs, and a few scattered glands with granular contents. In addition to these there are specific organs which call to mind the multinuclear colour- and chalk-glands which Leydig has observed in the skin of many terrestrial Gastropoda. They have no surrounding membrane, and the cell-substance generally is a finely granulated mass; the nuclei are from two to seven in number in each cell, and colour well. They are very easily seen to be connected with connective-tissue cells; and the author believes that both they and the cells observed by Leydig are only further developed connective-substance cells, which remain in contact with the other cells of the same substance.

Anatomy of Patella.*—Dr. H. Wegmann contributes some notes on the structure of *Patella*, an animal often, but only partially studied. His bibliography only comes down to 1883, and the recent thorough research by Mr. R. J. Harvey Gibson has apparently not reached the author. The two systems which are especially discussed are the alimentary and vascular. An Infusorian parasite found on the gills is also described. As the ground covered by Dr. Wegmann's research is in part included in Gibson's monograph, the detailed anatomical results need hardly be summarized. The value of the investigation is increased by the comparison which is instituted throughout between *Patella* and *Haliotis*, as also by the excellent illustrations.

Molluscoida.

α. Tunicata.

Muscular System of Glossophorum sabulosum.†—M. L. Lahille describes the well-developed muscular system of this Tunicate, which he finds to be very simple and instructive. There are generally six pairs of lateral muscles, corresponding to the six buccal lobes; occasionally eight pairs—a sign of approximation to the Cionidæ which is paralleled by other characters in the organization of *Glossophorum*—are present. The author remarks, parenthetically, that he is about to demonstrate the homology of what he calls the stolon (post-abdomen of Milne-Edwards) with the vessels of the tunic of simple Ascidians, the proliferating stolon of the Salpidæ, and the endostylar bud of Pyrosomatidæ. Owing to the fact that the ova are always developed on the right side of the rectum, the lateral muscles of the right are shorter than those on the left side of the animal. M. Lahille does not agree with Traustedt that the deviation of the intestine produces

* Rec. Zool. Suisse, iv. (1887) pp. 269–303 (2 pls.).
† Soc. l'Hist. Nat. Toulouse, xx. (1886) pp. 107–116.

the muscular asymmetry, but is of opinion that the latter is the cause of the former. The other longitudinal muscles are the cloacal, of which there are three pairs, and the dorsal and the ventral, of which there are, respectively, one pair.

Of the transverse muscles, the buccal and cloacal present no remarkable characters; the branchials are found in the interior of each transverse sinus. The muscular bundle is always single in *Glossophorum*, which is interesting as being a primitive arrangement, known as yet to obtain only in the Salpidæ. The statement of Della Valle that there are no muscular fibres in the gills of Tunicates is traversed.

The mesodermic cells, which are elongated, and which give rise to the muscular fibres, have at points along their internal walls refractive thickenings of contractile substance; these are developed from the periphery of the cell towards its centre, and so have, in section, a prismatic form. The prisms increase in size till they leave between their faces only an extremely thin layer of protoplasm. The author agrees with Profs. Van Beneden and Julin in thinking that the muscles of adult Tunicates are mesenchymatous in origin and epithelioid in formation. The organogeny of the musculature of the Tunicates appears to be always of one type; but in the Salpidæ and Urodele larvæ the mesodermic cells do not elongate.

The symmetry of the Tunicata, as of the Nematodes and lower Vertebrates, appears to be eutetrapleural and interradial, but this homology is an adaptational and not a primitive one.

β. Polyzoa.

Morphology of Bryozoa.*—Herr A. A. Ostroumoff concludes his study of the morphology of the Bryozoa of the Gulf of Sebastopol. In regard to the metamorphosis of all the three types he notes:—(1) the formation of the basal surface at the expense of the cells of the posterior wall of the vent (ventouse); (2) the histolysis of the provisional larval organs, and of the alimentary canal if it be always present (*M. zostericola*, *Cyphonautes*); (3) the formation of an ectodermic rudiment of the alimentary canal, formed by the cells of the cap (calotte) which is invaginated (Ctenostomata?); (4) the formation on the surface of this rudiment of a mesodermic layer arising from the mesoderm cells of the larva.

Budding and regeneration are discussed at some length, and the author emphasizes, in conclusion, the following four most important results:—(1) the calcareous skeleton of Bryozoa is deposited between the cells of the ectoderm, which persists throughout the life of the cells as a single layer under the skeleton (in *Membranipora*), or as a double layer inclosing the skeleton (in *Lepralia*); (2) the body-cavity is mesenchymatous, without endothelial lining; (3) the vent forms, in Cheilostomata, the basal wall of the cell, and the stolon in *Vesicularia;* on its derivatives the new members of the colony are always budded off, except the opercula avicularia in *Cellularia* and *Escharella;* (4) the polypide is formed at the expense of the ectodermic rudiment and of the brown mass; the larva still exhibits in its early embryonic life a peculiar organ, known as the cap (calotte), and destined to form the above-mentioned rudiment.

Morphology of Ectoproctous Bryozoa.†—Dr. W. J. Vigelius, who in 1884 suggested that the skin of the adult was represented by the ectocyst, and that the ectodermal epithelial layer which gives rise to the tegumentary

* Arch. Slav. de Biol., ii. (1886) pp. 329–55 (5 pls.).
† Tijdsch. Nederl. Dierk. Vereen., i. (1887) pp. 77–92 (1 pl.).

skeleton is only found in very young buds and afterwards disappears, has been led to reconsider this. He now finds that in *Farella repens*, and another species, probably a *Membranipora*, there is on the surface of the tegumentary skeleton a thread indicating an epithelium formed of very large cells; these cells closely resemble the ectodermal cells of *Loxosoma* and *Pedicellina;* it is very difficult to detect this layer except in specimens which, when fresh, have been treated with nitrate of silver.

The author's researches on *Flustra* have shown him that the endocyst and endosarc are formed of the same non-epithelial tissue; this parenchymatous tissue appears to be a special form of connective tissue which is massive in the cords and reticular in the layers which line the cavity of the body. In *Bugula calathus* it often contains a number of spherical or ellipsoidal corpuscles, which are granular in appearance; they vary greatly in their distribution. They multiply by division, and this is better seen in buds than in adults; their function seems to be that of formative elements, which serve either to nourish the tissues or to give rise to new cells in developing individuals, helping to form new organs. The muscular fibres are only these cells excessively elongated.

There can be no doubt that in the budding of the ectoproctous marine Bryozoa two distinct and well-developed embryonic layers take a part; the outer one is composed of large cells, in which the tegumentary skeleton is deposited, and the inner invests the cavity of the young bud and furnishes nearly the whole of the organs and tissues of the adult; in consequence of its situation and the part it plays in development it must be regarded as representing the mesodermal layer. In the early stages it forms an epithelium, which does not persist, but is converted into ovicells or aviculariæ, or furnishes the different organs which fill the cavity of the bud; it also provides the materials for the development of the nutritive apparatus. In this last both ectoderm and mesoderm take a share. If it be admitted that the endoderm is wanting, then the epithelial layer which invests the cavity of the young bud ought to be considered as representing both mesoderm and endoderm; from the time of the formation of the gastrula the elements of the inner layer are fused with the internal cellular mass of the embryo.

Morphology of Marine Bryozoa.*—Dr. W. J. Vigelius gives a preliminary notice of his results with regard to the morphology of ectoproctous marine Ctenostomatous and Cyclostomatous Bryozoa. The ectodermal epithelium has been studied by silver preparations of *Bugula, Membranipora, Flustra,* and *Mimosella;* in the adult of all it consists of large, much-flattened cells, and in the rudiments of the bud of smaller polygonal cells. Contrary to Kohwey, Dr. Vigelius believes that the fine partition-walls which separate the individuals of *Alcyonidium* from one another are perforated, and so correspond to the communication-plates which are so often found in the Ectoprocta.

With the exception of *Alcyonidium* all the forms examined had the parenchymatous tissue developed on one and the same type; and this closely corresponds to what the author has already found in *Flustra membranaceo-truncata* and *Bugula calathus.* The nutrient apparatus is very much the same in all forms; the cilia of the tentacles of preserved specimens were seen to be arranged in the same way as in *Flustra; Zoobotryon* and *Mimosella,* in addition to the pharynx, stomach, cæcum, and intestine of other forms, have a masticatory stomach. The circular canal is always found, and is invested by the continuation of the mesenchymatous layer which is found in the tentacular canal; in *Alcyonidium mytili* the author

* Zool. Anzeig., x. (1887) pp. 237–40.

was able to detect within the circular canal, on the anal side, a sharply defined organ, which looked very like a ganglion. The gonads are always products of the parenchymatous tissue, but the size of the ovary and ova varies considerably; in *Flustra carbasea* the spermatozoa-spheres form a compact cell-mass. In *Crisia* the formation of the generative cells appears to go on exclusively in the brood-capsules. The intertentacular organ of *Alcyonidium mytili* is not present in all functional individuals of the colony; it lies beneath the tentacular sheath, has an epithelial investment, and is fused for a large part of its course with the adjacent tentacles of either side.

γ. Brachiopoda.

Anatomy of Brachiopoda Articulata.*—Dr. L. Joubin, who has already investigated the inarticulate Brachiopoda, has extended his studies to *Terebratulina*, *Argiope*, &c. Longitudinal sections of young forms show that the peduncle is a sac which is entirely closed, and is applied against the hind wall of the mantle, an arrangement, therefore, analogous to what obtains in *Discina*. By the aid of figures the author describes the minute structure of the stalk and of its appendages. These latter can only be made out in young forms, as they soon become incrusted. There are a varying number of small yellowish hairs, which terminate by a kind of sucker. The hairs are hollow, and the walls are formed of a series of zones arranged concentrically round a lumen. Each hair is fixed in the thick layer of cartilaginous tissue which forms the end of the peduncle. In function they appear to be comparable to the byssus threads of lamellibranch molluscs, but in their mode of development, and their morphological relations, they are altogether different.

Cæcal Processes of Shells of Brachiopoda.†—Prof. W. J. Sollas adduces evidence that the so-called cæcal processes of the shells of Brachiopods are sense-organs; they are obviously composed of epithelial cells, and in their centre they show traces of an axial fibre, which can be seen to be continuous with the nerve-cells of the mantle. At the outer end of the tubule there is a single large finely granular cell, with a large oval nucleus and spherical nucleolus, and there may be, in addition to it, a number of other nuclei. The inner end of the terminal cell appears to be prolonged into a fibril, which can sometimes be traced into continuity with both the nucleus and the axial fibre. The cæcal tubes of *Waldheimia cranium* are, therefore, epidermal outgrowths with a large terminal granular cell, which is continued proximally into a nerve-fibril and is covered distally by a transparent chitinous layer, separating it from all external influences likely to serve as stimuli except that of light; that, however, the cæcal process is an organ for the perception of light cannot yet be taken as proved, owing, especially, to the absence of anything like pigment in the terminal cells. Specimens better prepared may perhaps add to our information on this point.

Arthropoda.

Relations of Groups of Arthropoda.‡—Prof. C. Claus states that the "essential points" on which he insists are—

(1) He independently supported, eleven years ago, the phylogenetic origin of Scorpions and other Arachnoids from the Gigantostraca.

* Bull. Soc. Zool. France, xii. (1887) pp. 119–26 (1 pl.).
† Scientif. Proc. R. Dublin Soc., v. (1887) pp. 318–20 (1 fig.).
‡ Arbeit. Zool.-Zoot. Inst. Wien, vii. Cf. Ann. and Mag. Nat. Hist, xix. (1887) p. 396.

(2) In 1880 he "implicitly" stated the distinction of the three Arthropod series—Crustacea; Gigantostraca, Arachnoidea; Myriopoda-Insecta.

(3) His views as to the relation of *Limulus* to the Arachnoidea are quite different from those of Prof. Ray Lankester.

(4) The reference of the Mites to retrograde Arachnoidea, which is supported by the discovery of the rudimentary heart, has been for many years supported on other grounds than those of Lankester.

(5) The hypothesis of the "adaptational shifting of the oral aperture" is perfectly untenable.

(6) And it has nothing in common with the opinion, founded on the conditions of innervation, that the second pair of antennæ of the Crustacea represents the foremost truncal members, while the first pair, like the antennæ of Insecta and Myriopoda, belong to the præstomial part of the head.

α. Insecta.

Some interesting processes in the formation of Insects' Ova.*—Dr. E. Korschelt, as a first of a series of accounts of interesting processes in the formation of the ova of insects, gives a description of an abnormal mode of development in the origin of the egg-rays of *Ranatra linearis.* This may be taken as a supplement to his description of the peculiar mode of formation of the chitin of the so-called egg-rays of *Nepa cinerea.* In that form the egg has at its upper pole seven filamentous appendages—the egg-rays—which serve to bring air to the submerged egg. For this object they are porous at their tip and internally, and this porous substance is connected with a similarly porous layer in the egg-shell. The rays of *Nepa* do not arise in the usual way in which chitin is formed, for they are not cuticular products excreted by the epithelial cells, but are developed within specially modified cells. The allied *Ranatra linearis* has two rays only, but these are longer than those of *Nepa*, with which they agree in internal structure. While the egg-shell proper is developed in the typical mode of chitin formation, the rays are, as in *Nepa*, formed within specially modified cells. The epithelial tissue thickens in the upper lateral wall of the younger ovarian chambers. Owing to this increase in size, the upper wall gets a ridge-like thickening. In the youngest chambers this consists of similar cells, but in those that are a little older the nuclei begin to increase in number. Among the epithelial nuclei of the ordinary size there appear some larger ones, which are already so far altered that they appear to be filled with a number of small chromatin particles. In a more advanced stage the increase in size becomes more marked, and this goes on with age. Plasmatic spaces appear around the larger nuclei, which thus look as though they were surrounded by a cell-body. The increase in the size of the nuclei is accompanied by a multiplication of the cells, and the thickening, within which the rays are to be formed later on, is very different from the rest of the cell-wall. The next process which becomes noticeable is that four of the larger nuclei arrange themselves by pairs, and become almost completely attached to one another. Henceforward these are the cells which grow most, all the other nuclei being left far behind. The histological structure which contains the two nuclei may be well called the double cell. In *Ranatra* it is not so early or so strikingly characterized as in *Nepa*. The chitin of the egg-rays is formed within the double cells between the nuclei, the cell-plasma which lies there being directly converted into the chitinous substance; the ray is first formed at its base, and begins to grow considerably. The cuticula-like layer

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 327–97 (2 pls.).

which invests the ray, and which is homogeneous, is not, in *Ranatra*, formed within the double cells, but is secreted by the neighbouring cells in the form of a cuticle; and we have, therefore, the somewhat remarkable phenomena of the union of a rare form of intracellular chitin formation with the ordinary or typical form of cuticular secretion of chitin. The observation of the whole process of chitinization leads the author to the belief that it is due to the direct influence of the nuclei on the activity of the cell. Although the substance given off by the nutrient and the double cells is so different in nature, yet it is impossible to dispute the similarity of the two processes. In both kinds of cells, i.e. in the nutrient cells of Lepidoptera and the double cells of *Nepa* and *Ranatra*, the nucleus extends in the form of amœboid processes through the cell; and as in both cases a substance is excreted by the cell, it is very probable that the nucleus thus increases its surface for the purpose of increasing the constant action between the nuclear and the cell-substance. It thus exerts a greater influence on the secretory activity of the cell.

The second chapter deals with the exit of the ovum from the ovary, and the fate of the empty ovarian follicle; and with the relation of the egg-forming organ to the efferent apparatus. The result of the investigation of a number of forms is this: the ova always make their exit from the ovarian tube in one typical way, which, however, presents a number of variations due to the characters of the ovarian chamber after repeated ovipositions; the variations may be ascribed to the variations in the form of the ovarian tube, and to the characters of its epithelium. In all cases the egg-chamber is broken through at its base, since here there is always a cellular partition, which opposes the passage of the ova from the ovary into the efferent apparatus; the injury suffered by the tube varies considerably. Sometimes there is not only fissure, but an extension of the constriction at the base of the tube, when the egg passes from the tube into the duct without the connection between the two being broken. In other cases, however, when the epithelium of the ovarian chamber forms a very thin layer, the exit of the ova is accompanied by a destruction of the epithelium, and the consequent breaking up of the whole chamber, of which the tunica propria alone remains; here, of course, the connection between the ovigerous and the oviducal organs is suddenly broken; it is more marked when the constriction between the separate egg-chambers has gone so far, that they are only connected by a thin filamentary piece, for here it is impossible for the ova to pass on; the ovigerous and oviducal portions may in these cases be connected by nothing but the surrounding peritoneal investment; the walls of the emptied egg-chamber fall together, and form isolated balls of cellular substance, until they are absorbed. We have here, it is obvious, to do with a very interesting phenomenon; the true ovary as represented by the oviducal tube is, by a normal act of destruction, separated from the rest of the generative apparatus; in certain cases the ovary again becomes connected with the efferent apparatus, and the solution and reparation of continuity is periodically effected.

In the third chapter, Dr. Korschelt deals with abnormal processes in the development of insects' eggs. In *Reduvius personatus* and *Bombus lapidarius* the lowest ovarian chamber has its wall considerably thickened, as if in consequence of the thickening of the epithelial cells; and the chamber seems at first to have been emptied and to be undergoing retrograde change; closer examination, however, shows that we have to do with a chamber which still contains ovarian rudiments, although altered in condition.

In *Reduvius personatus* the lowest ovarian follicles of some of the tubes

have a thick wall formed of several epithelial layers, the cells of which are quite irregularly arranged, and show signs of degeneration, while there are lacunæ between the cells. The yolk-mass is vesicular and spongy. There can be no doubt that we have here to do with a pathological condition. *Bombus lapidarius* presented just the same phenomena.

The fourth chapter treats of an increase of surface caused by the development of folds on the inner side of the follicular epithelium of *Rhizotrogus solstitialis;* the folds are caused by an invagination of the unilaminar epithelial layer within the egg, and they may extend to the middle of the ovum; when deep there are never more than three; it is to be noted that folds and villi are to be seen on the inner wall of the oviduct. Against the supposition that they are abnormal we have to put the fact that they are found in eggs of all stages and of histologically normal character; nor can they be thought to be due to the faults of preparation. It is possible, then, that the folds are normal and have for their function an increase in the surface of the egg with a view to its better nourishment; with the growth of the eggs the folds disappear. What happens here cannot but remind us of the numerous folds found by Lankester in the cellular egg-capsule of the Cephalopoda.

Polar Globules in Insect Ova.*—Dr. F. Blochmann has shown (1) that in five classes of insects the ovum is never without a nucleus; (2) that in *Musca vomitoria*, in the winter ova of *Aphis aceris*, &c., polar globules are formed; (3) that in some parthenogenetic ova at least only one polar globule is formed, while in the normally fertilized two are present.

In the winter ova of *Aphis aceris* two cells are extruded in normal fashion; the first occasionally gave indications of a nuclear spindle. In two species the summer parthenogenetic ova exhibited only a single polar cell, an observation of some suggestiveness as to the physiological import of these extruded elements.

In *Musca vomitoria* a polar globule formation does indeed take place, but the elements are not extruded. Three results of nuclear division remain for a while in a peripheral thickening, the fourth forming the female pronucleus. Polar globules have now been observed in three classes of insects.

Photogenic Function of Ova of Lampyris.†—Dr. R. Dubois has found that the ova are luminous in ovaries taken from the abdominal cavity of *Lampyris*, and carefully washed immediately after removal; the eggs of both fertilized and non-fertilized individuals are luminous, and the development of the light is in direct relation with the degree of intra-ovarial development of the ova. The luminosity persists in laid eggs until the embryo escapes; the shell abandoned by the larva does not remain luminous, but the creature itself has two luminous organs at the moment of birth; the luminosity of laid non-fertilized eggs does not last beyond a week, and it has been noticed in eggs in which there is no trace of segmentation. The hygrometric condition of the surrounding medium exercises a great influence on the production of the light, which becomes weakened or extinguished as soon as the moss on which the eggs have been deposited becomes a little dry; if the dryness has not gone too far, the addition of a little moisture causes the luminosity to reappear.

Boiling water immediately and alcohol rapidly suppresses the luminosity; eggs washed and shaken in distilled water do not give up their

* Biol. Centralbl., vii. (1887) pp. 108–11.
† Bull. Soc. Zool. France, xii. (1887) pp. 137–44.

luminosity to it; if kept for much more than an hour in water, the eggs begin to lose their photogenic properties; but if withdrawn at such a moment, the light-giving power gradually returns. It is easy to show, as by pricking the egg with a teasing needle, that the substance contained in the shell of the egg is luminous by itself; if parts of the tissue of the luminous organ are rubbed lightly on a sheet of paper there are luminous marks, but nothing of the kind occurs if the shell remains intact.

The photogenic power is exercised in the egg without the aid of tracheæ, nerves, or special anatomical elements, and the continuity of the light is the result of the vital processes of the egg of *Lampyris noctiluca*.

Senses of Insects.*—M. A. Forel contributes a most interesting and exhaustive account of experiments made by himself and many others on the much discussed problem of the senses of insects.

(1) In regard to *sight* of ants, he notes especially these three conclusions:—(*a*) They perceive light, and particularly ultra-violet (Lubbock); (*b*) they really see the ultra-violet rays, without eyes they are almost indifferent to them, and only respond to solar light more or less intense; (*c*) the dermatoptric sensations are feebler among ants than in the animals which Graber studied.

(2) After reviewing new and old experiments, as to the sense of smell in insects, he notes the following general facts:—(*a*) In many insects which are essentially directed by sight, as in the Libellulids and Cicadas, the antennæ are rudimentary, and the sense of smell likewise. During the night these insects are passive, while during the day they trust to their power of sight, or possibly in some cigalids also to hearing; (*b*) the sensitive region, in spite of Graber's protestations, is situated in the antennæ, especially in those parts where the antennary nerve ramifies; (*c*) in certain insects, as in most Diptera, the antennæ probably serve almost solely for smelling purposes; (*d*) in other cases, however, where they are mobile, as in the Hymenoptera, they are used for detecting their food or their mates at great distances.

(3) As distinct organs of taste, M. Forel regards the nervous terminations (*a*) on the proboscis of flies (Leydig), (*b*) on the jaws and on the base of the tongue (Meinert), (*c*) on the end of the tongue (Forel), and (*d*) on the palate or on the epipharynx (Wolff).

(4 and 5) Forel's results as to hearing are as yet too negative to admit of notice. He finally discusses the sense of touch in its various manifestations, and the last chapter of his interesting memoir discusses the relation of the five senses to the general psychical life of insects.

Cell of the Honey Bee.†—Prof. H. Hennessy has a second note on the geometrical construction of the cell of the honey bee; he finds that a sphere may be inscribed within the cell from a point measured from the vertex at a distance equal to the side of one of the lozenges, and with a radius equal to half the long diagonal of this lozenge, while another sphere with a diameter equal to three times the size of the lozenge circumscribes the triangular pyramid at the summit. If D′ be the diameter of the inscribed sphere, and D that of the exterior sphere, the relation between them may be expressed thus:—

$$\frac{D}{D'} = \left(\frac{3}{2}\right)^{\frac{3}{2}}.$$

* Rec. Zool. Suisse, iv. (1887) pp. 161–240.
† Proc. Roy. Soc. Lond., xlii. (1887) pp. 176–7.

The relation between the geometrical cell and the interior and exterior spheres may possibly have some bearing on the question of the formation of the actual cells.

Brain of Vespa crabro and V. vulgaris.*—M. H. Viallanes, in the fourth of his memoirs on the structure and histology of the nervous centres of Articulata, deals with the brain of *Vespa crabro*, and *V. vulgaris*. He divides the brain into three great regions, which he calls protocerebrum, deutocerebrum, and tritocerebrum ("protocerebron," &c.); the first of these consist of the two optic ganglia, the three ocellar ganglia, and the median protocerebrum. The optical ganglion is almost identical in constitution with that of *Libellula*, and consists of post-retinal fibres, ganglionic layer, external chiasma, external medullary mass, internal chiasma and internal medullary mass. The optic nerve connects the ganglion with the median protocerebrum, and is composed of four perfectly distinct bundles, two of which are superior and two inferior; of the latter, one is very large, and is formed of two distinct cords. The ocellar ganglia are found beneath the ocelli; each consists of a mass of dotted substance, which is fairly homogeneous, and has connected with it small nervous cells, in which the protoplasm is much reduced. The median protocerebrum is made up of two pedunculated bodies, two cerebral lobes, and a central body. The first of these consists of the internal and external calyx, together with the stalk: the elliptical calyces have their walls formed of a thick layer of dotted substance, and both their internal and external surfaces are invested by a thick layer of small nerve-cells. Five parts are to be distinguished in the peduncle, the stalk of which is united to the substance of the cerebral lobes by two large fibrous bundles. The central body, although consisting almost exclusively of dotted substance, has a complex structure; it enters into relation with nearly all the constituents of the protocerebrum, fibres extending to the cortex, to the calices, to the cerebral lobes, the œsophageal commissure, and the olfactory lobes.

The two cerebral lobes are intimately connected beneath the central body; they are essentially formed of dotted substance, among which are a large number of fibrous bundles with definite courses; the connection between the lobes is effected by two commissures, one superior and one inferior; the œsophageal commissures are very voluminous and are continuous with the cerebral lobes; they also consist of a very homogeneous dotted substance, among which are a few bundles of well-marked fibres. Attached to the protocerebrum is a special organ which the author calls the wings of the cerebral lobe; it is entirely formed of dotted substance, and is everywhere surrounded by ganglionic cells.

The cerebral lobes are themselves everywhere surrounded by nerve-cells arranged in layers, which are thickest behind and in the median region; the prolongations which they give off pass to the central body, to the stalk of the pedunculated body, and to the olfactory lobe, as well as to the cerebral. The deutocerebrum is represented by the two olfactory lobes, each of which has the form of a rounded projection, attached by a short stalk to the anterior face of the corresponding œsophageal commissure. The structure is very characteristic; the central part is formed of somewhat loosely arranged dotted substance, and the cortical consists of a layer of olfactory glomeruli; each of these last has the appearance of a small sphere of dotted substance, and is united to the central part of the lobe by a short peduncle which is formed of the same substance. The outer face of the olfactory lobe is invested by a thick layer of small cells altogether similar

* Ann. Sci. Nat., ii. (1887) Art. No. 1, 100 pp., 6 pls.

to those which invest the calices; the prolongations which they give off are grouped into bundles which make their way among the olfactory glomeruli, and are lost in the central dotted substance of the lobe. In the pedicle there are fibres and dotted substance; the antennary nerve is composed of two bundles. The tritocerebrum, unlike what happens in some insects, notably the Orthoptera, is fused with the neighbouring parts, and can only be distinguished by the point of origin of the common trunk of the nerve for the labrum and the stomatogastric nerve.

Life-history of Ugimya sericaria.*—Prof. C. Sasaki gives an account of the life-history of *Ugimya sericaria*, the Dipteron whose larva plays terrible havoc among the silk-worms which are raised in Japan in May and July. After describing the external and internal anatomy of the adult fly, in which particular attention is given to the structure of the generative organs, the development of the maggot is considered; the greater number of eggs are laid in May, and deposited on mulberry bushes, with the leaves of which they are eaten by the silkworm; owing to their small size and hard chitinous covering they are not crushed by the strong jaws of the silkworm, and pass uninjured into the digestive tract. In one to nine hours the shell breaks open by a longitudinal slit on its flat surface; the escaped maggot is invested in a thick transparent oval sac, which soon opens at one end, when the tiny creature becomes free. After one to eight hours the maggot, probably by the aid of its hooked jaw, passes through the wall of the canal and enters directly into the ganglia which lie close beneath; ordinarily the silkworm is now weakened, and its body presents an unusual aspect from the severe irritation of the nervous system. The appearance produced may be understood from the popular name of "swelled segment" which is given to the disease. Feeding on the ganglion-cells the parasite grows larger and larger; after about a week it passes into the body and "directly searches for the portions of the tracheal system of its host where the stigmata open." Here it forms a sort of cup by heaping up the fats and muscular fibres of its host round the opening made on entering, and sticking them together with its saliva; it now feeds entirely on fat. The presence of a dark brown or blackish patch round the stigma is conclusive evidence of the presence of the parasite. In addition to the disease mentioned, other diseases and symptoms may be caused by the presence of the maggot.

When it reaches maturity the maggot leaves its abode in the body of the silkworm or its pupa, and, making a hole in any part of the body of its host, it passes into the cocoon, and thence to the outer world. The author describes in detail the habits and anatomy of the mature maggot, the structure of the pupa, and its developement into the mature insect, and concludes a very interesting essay by some suggestions as to the protective methods which should be adopted. It is interesting to note that the pupa of this fly is itself infested by a parasitic mite, which probably belongs to the genus *Tyroglyphus*.

Pedigree Moth-breeding.†—In order to obtain new data for verifying certain important constants in the general theory of heredity, Mr. Francis Galton proposes to experiment on moths, more especially on those which are double-brooded. He points out the advantages, such as the short lives, no change in length of wing, and ease of rearing and preserving, &c., to be obtained by using moths as subjects.

It is intended to start from a brood of a single pair of moths, and to

* Journ. College of Science, Imp. Univ. Japan, i. (1886) pp. 1–46 (6 pls.).
† Trans. Entom. Soc. Lond., 1887, pp. 19–28.

trace the changes of some one characteristic, e. g. length of wing, during several successive generations. Three lines of descent will be contrasted, viz. shortest winged, longest winged, and medium winged, in each generation.

For measuring the length of wing of living moths, he proposes a pair of scissor-like compasses, with arms on one side of the joint, being five times the length of those the other side, and the long arms furnished with an index marked in 1/2 millimetres. He has also tried the glasses from one of the tubes of an opera-glass, with a lengthened interval between them, so as to form a Microscope of very long focus, say 18 in. This was fixed to a light rod that carried a millimetre scale, set across its free end, at a trifle less than 18 in. from the object-glass. On approaching the scale to within half an inch of any small object, that object and the scale are both in fair focus at once, and they are sufficiently far from the eye to render any error (arising from slight change in position of the eye) of little or no importance.

For accurate measurements of dead moths, Mr. Galton has a much better instrument under construction, in which there is a small Microscope with cross wires, in the short limb of a pentagraph, the long limb being used both for setting the Microscope and for reading off the measurements.

The author then details his method of centering the measurements, by means of a curve through the ends of ordinates, such as he has used in other measurements.

Histology of Enteric Canal of Insects.*—M. V. Faussek has observed in *Eremobia muricata* the same kind of glandular structures between the cells of the cylindrical epithelium of the midgut, to which Frenzel has applied the name of glandular crypts. They have the form of narrow-necked flasks, and are filled by a mass of closely applied nuclei, which do not differ essentially from the nuclei of epithelial cells. The hind-gut consists of two sections, connected with one another by a delicate coiled tube. This has a strong muscular layer, and is lined by an epithelium, which consists of very small cells, is raised up into folds, and provided with a thick intima. On the contraction of the muscular elements, these folds must close the lumen of the tube. In the portion of the tract which lies above the connecting tube, the epithelium consists of long broad cells, with very large nuclei, each of which is surrounded by a transparent area. The other part of the tract is occupied by six longitudinal ridges of the epithelial layer—the so-called rectal glands. In the epithelium of these there are two kinds of cells, some being higher and cylindrical, others less distinctly marked and mucous. The nuclei of the latter are of small size, and each occupies the centre of a clear vesicular space. The space between the epithelial layer and the musculature is filled by a loose fibrous connective tissue, the limits of the separate cells of which are not preserved. The tracheæ branch in this tissue, and fine ramules make their way between the epithelial cells, and end in small blind enlargements.

Some interesting observations were made on the structure of the hind-gut in larvæ of *Æschna* and *Libellula*. The muscular layer is feebly, but the epithelial well developed. The latter consists of two kinds of cells in different regions. Some are large and cylindrical, with large granules, and these form folds, into which enter pretty thick tracheal branches. This kind passes gradually into the second, in which the cells and their nuclei are small; and the protoplasm does not stain with carmine. The layer formed by these is arranged in numerous complicated folds, and appears in cross

* Zool. Anzeig., x. (1887) pp. 322–3.

section as if it were made up of gland-like cell-complexes. The enteric gills are irregularly invested by two kinds of epithelium; in the terminal portion of the hind-gut the enteric gills disappear, and are replaced by typical rectal glands, the presence of which speaks in favour of Chun's supposition that the rectal glands are not structures which have been altered by disuse.

Glandular Secretion of free Iodine.*—Dr. J. C. C. Loman found that, on keeping for five days a specimen of the rare beetle *Cerapterus 4-maculatus*, a distinct odour of iodine was perceptible. This was excreted in drops, and when tested by ether, alcohol, and starch, found to be truly iodine. The iodine was found, on dissection, to be secreted by the anal glands. These, as in other species of Coleoptera, consist of two extremely fine coiled tubules, provided with a pyriform lateral swelling. The walls of this are thickly covered with muscular tissue; and it may be regarded as a reservoir or propulsive organ. The function of this secretion appears to be defensive.

Modification of Habits in Ants through fear of Enemies.†—Dr. H. C. McCook observed a raid of *Formica sanguinea* on a nest of *F. fusca*, which proved a failure. The instinct for kidnapping has appeared to develope, on the part of those who are the victims, a corresponding strengthening of instinct in the way of concealment. When the latter are not exposed to the acts of the former, they raise above the surface of the ground a mound of more or less considerable size, and over its summit and at the base the gates are scattered without the least attempt at concealment. But when a colony of their enemies is near, they omit or subdue elevations above the surface, their gates are few and cunningly concealed, and quantities of rubbish are scattered around, with the evident intention of hiding the locality of their nest, or making the approach to it more difficult. A similar faculty has been observed in *F. schaufussi*.

Vesicating Insects.‡—Continuing his monographic researches on Meloidæ, M. H. Beauregard discusses the spermatogenesis, and the various external and internal structures associated with the reproductive system.

1. *Spermatogenesis.*—On the internal wall of the testicular tubules (*a*) large cells are seen with spherical nucleus, and among these (*b*) small spherical groups of four or six cells of pyramidal form, and arranged in stellate fashion, with convergent summits. These groups of small cells arise from the division of the larger. The cells of the groups multiply by division, and not by budding, and form the spermatic spheres described by Balbiani. The final result of division is the formation of what Beauregard calls "spermatoblasts," each of which gives origin to a spermatic filament. The spermatic sphere is from the first to last enveloped in a fine protoplasmic layer with a nucleus. This is due to one of the original halves of the male ovule, the other half, of course, dividing to form the "spermatoblasts." The further ontogeny of the sperms is traced, and notice is taken of the relevant observations of Gilson and Wielowieyski.

2. *The external male organs* are next described in a number of typical forms. The bivalved copulatory apparatus, with the groove surrounding the penis, is also described in detail.

3. *Female apparatus.*—The third part of the memoir discusses the various structures which make up the female organs. These do not differ in any marked feature from those usually found in Coleoptera. M. Beau-

* Tijdschr. Nederl. Dierk. Ver., i. (1886–7) pp. 106–8.
† Proc. Acad. Sci. Philad., 1887, pp. 27–9.
‡ Journ. Anat. et Physiol., xxiii. (1887) pp. 124–63 (6 pls.).

regard distinguishes two groups—(1) those in which a seminal reservoir and accessory gland are present; (2) those in which the accessory gland is absent, and the seminal reservoir approximated to the orifice of the oviduct. The female genital armature formed from the ninth urite is then discussed, with special reference to the conclusions of Lacaze-Duthiers. The histological details of M. Beauregard's careful investigations are hardly adapted for compressed summary.

Fossil Insects.*—Dr. S. H. Scudder gives a systematic review of our present knowledge of fossil insects, including myriopods and spiders. It is essentially a translation for the benefit of English readers of the text furnished by the author to Dr. Zittel for his 'Handbuch der Paleontologie.' The German text, however, is accompanied by more than two hundred illustrations. M. Barrois is also publishing a French version. Each section of the work is accompanied by a complete bibliography, which shows at a glance how recently this department of paleontology has been developed (very few of the titles dating back beyond 1850), and how extensive and varied the author's own contributions have been. The concise descriptions of the classes, orders, and families are accompanied by brief notes on the fossil genera and species, with the locality and geological horizon in many cases; while the stratigraphic distribution and range of each order are shown by tables giving the number of species found in the rocks of each age. No fewer than 2600 species of true insects have been found fossil up to the present time. The great majority of these, as well as of myriopods and arachnids, are from the middle tertiary. This great irregularity in the chronological distribution of the fossil forms, which is, of course, due largely to the character of the deposits, is a plain indication that important insect fauna still remain to be discovered. Thus, of the fossil spiders, 31 forms are known from the palæozoic strata, 1 from the mesozoic, and 285 from the tertiary, the great majority of the tertiary forms having been found in the amber deposits of Prussia.

γ. Prototracheata.

Development of Cape Species of Peripatus.†—Mr. A. Sedgwick commences his third memoir on the development of *Peripatus* by a brief reference to the criticisms and arguments of Dr. Kennel. In the ectoderm there appear lateral thickenings, which are continuous from somite to somite; the ventral part of these gives rise to rounded elements, which go to form the nervous system; the elements are formed first in the preoral region and then in the lateral cords; or, in other words, the nervous system, at its very first appearance, begins in front of the mouth, where it is continuous across the middle line, and it extends backwards, continuously, on either side; the central ganglia give rise directly to the eyes and tentacular nerves, the portions around the mouth become the circumoral commissures, and the hinder portions are the rudiments of the ventral nerve-cords of the adult. A distinction must be drawn between the true body-cavity and the large apparent body-cavity, which may be called the pseudocœle or vascular space; the adult body-cavity comes entirely from the pseudocœle, and both heart and pericardium are pseudocœlic; the only products of the enterocœle cavity are the nephridia and the generative glands with their ducts; neither in the embryo nor in the adult do the nephridia open into the pseudocœle, but into a vesicle in each appendage which has been hitherto

* Bull. U.S. Geol. Survey, No. 31. Cf. Science, ix. (1887) p. 426.
† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 467–550 (4 pls.).

unnoticed. These characters, when taken with the peculiarities of arthropod organization—the feeble development of the somites, the apparent absence of nephridia, the vascular character of the pericardial cavity, and the possession by the heart of lateral ostia opening into the pericardium—are of great morphological interest.

Developing, later on, the general results which follow on the pseudocœlic character of the body-cavity, Mr. Sedgwick defines a cœlom as a cavity which (1) does not communicate with the vascular system, (2) does communicate by nephridial pores with the exterior, (3) gives rise by its lining to generative products, and (4) developes either as one or more diverticula from the primitive enteron, or as a space or spaces in the unsegmented or segmented mesoblastic bands. Now the vascular space has none of these characters; it developes either from the blastocœle or from a system of channels hollowed out in the mesodermic tissue of the body. In Annelids and Vertebrates the two spaces co-exist; in the Arthropoda it is very probable that the cœlom persists as the gonads and their ducts, but for the most part vanishes, giving rise possibly to glands of a doubtful nephridial nature, while the body-cavity and vascular system have an exclusively pseudocœlic origin; in the Mollusca the cœlom and vascular space have not been sufficiently distinguished from one another; there seems, however, to be no doubt that the pericardial cavity of the Lamellibranchiata and Gastropoda represents the entire cœlom, for it is always shut off from the vascular system, and it communicates with the exterior by a pair of nephridia. The considerations urged as to the distinctness of cœlom and vascular system do not, at present, seem to apply to the Nemertinea or Hirudinea.

In most animals the vascular space or pseudocœle appears before the cœlom, but in *Peripatus* the cœlom appears first; in arthropods, at least, the vascular space is in the early stages very commonly occupied by yolk, while the cœlom is entirely free from it; there may be, therefore, some connection between the vascular and the enteric spaces.

The true cœlom of *Peripatus* appears in the ordinary manner as a series of cavities, one in each mesoblastic somite; these, which are at first ventro-lateral in position, soon acquire a dorsal extension, and the contained cavity becomes divided into a ventral part, which passes into the appendage, and a dorsal part, which comes into contact but does not unite with its fellow of the opposite side on the dorsal wall of the enteron. The dorsal portions soon become obliterated in the anterior part of the body, but posteriorly they unite with those of their own side to form the generative tubes. The ventral portions retain their isolation throughout life, and give rise to a coiled tube, which is the nephridium of the adult, and a small vesicle which is contained in the appendage, and constitutes the internal blind end of the nephridial portion of the somite. The body-cavity consists of four divisions—a central compartment which contains the intestine and gonads, a pericardial cavity, lateral compartments containing the nerve-cords and salivary glands, and the portion in the appendage.

If it is true, as is likely, that the cœlomic relations of other Arthropods are similar to those of *Peripatus*, we may add to the definition of the group the terms—cœlom inconspicuous, body-cavity consisting entirely of vascular spaces; while in Vertebrates and most Annelids the body-cavity is entirely cœlomic, and the vascular spaces are broken up into a complicated system of channels, and in Mollusca generally the pericardium alone is cœlomic, and the vascular spaces are represented by the heart and the more or less complicated system of spaces in the body.

Mr. Sedgwick enters with some detail into the incomplete segmentation

and syncytial nature of the embryo, as to which he has already made some remarks. *Peripatus capensis* is remarkable, even if not unique, among animals for the large size of its egg, combined with the almost complete absence of yolk; the history of its segmentation shows that at no period of development are the cells which arise from that segmentation completely isolated units; on the other hand it is quite certain that in small holoblastic eggs the cleavage is complete, and the question naturally arises, is the complete or the incomplete cleavage phylogenetically the more correct. In answer to this we may observe that no animal is composed of a mass of separate and similar cells, that complete cleavage is probably very much rarer than is generally supposed; when such a cleavage does take place it may possibly be due to "an intensely active force in the centre of the cell, which compels for the moment the assumption of this (clean rounded) form in the protoplasm over which it has dominion." The phenomena of segmentation in the ova of various Crustacea suggest that it may be possible to find a purely mechanical explanation of complete cleavage. The supposition that the ancestral Metazoon was a colonial Protozoon is not supported by holoblastic segmentation, but is somewhat favoured by what we know about incomplete cleavage.

The view, however, which is in accordance with the facts of development of *Peripatus capensis* is the old doctrine that the ancestral Metazoon was a multinucleated infusorian-like animal. But this view is, after all, only "a more or less plausible suggestion without any strong basis in fact." Mr. Sedgwick proceeds to criticize the speculations of Metschnikoff, and points out certain difficulties and misunderstandings; the chief point in which they disagree is that Mr. Sedgwick cannot accept the view that the hollow blastula is a primitive form, or that the formation of the endoderm by migration inwards of the cells is a primary process. Attention is directed to the fact that the formation of mesoderm in *Peripatus* is essentially a formation of nuclei which pass to their respective positions and arrange themselves in the protoplasmic reticulum there present, and to the observation that the primitive streak is the growing point of the animal, from which almost all the tissues of the adult are derived; its nuclei, therefore, are not merely mesodermal, but are also ectodermal and endodermal.

δ. Arachnida.

Morphological Significance of so-called Malpighian Vessels of two Spiders.*—Dr. J. C. C. Loman has made transverse sections through the hinder part of the body of a *Cteniza* from West Java, the examination of which shows that the two excretory ducts are appendages of the midgut; similar relations have been observed in *Epeira*, *Tegenaria*, and *Mygale*. Other points of difference between these ducts and the Malpighian vessels of insects are to be found in (1) the structure of the separate cells, which in spiders are of the type of enteric epithelial cells, and (2) as to their function, for the contents of the spider's ducts are fluid, and their slight contents are by no means of the character of renal concretions; uric acid and uric salts were wanting.

The resemblance of these tubes to the tubular excretory organs which have been shown by Spencer to be connected with the midgut in *Oniscus*, *Gammarus*, &c., is another indication of that connection between the Arachnida and the Crustacea rather than the Insecta, which recent studies have gone so far to support.

* Tijdschr. Nederl. Dierk. Vereen., i. (1886-7) pp. 109-13.

Chorioptes (or Symbiotes) on Birds.*—M. L. Trouessart, remarking that *Sarcoptes* is the only acarid that has yet been certainly found on birds, now directs attention to the discovery by MM. Rivolta and Caparini on fowls, of two acari which they call *Epidermoptes bifurcatus* and *E. bilobatus*; the latter is synonymous with *Symbiotes avium*; these creatures appear to the naturalists just named to be the cause of grave attacks of psoriasis.

M. Trouessart, however, agrees with M. Neumann, that the psoriasis is rather due to *Achorion Schönleinii*, and thinks that the figures given of *Epidermoptes* show that that genus has not the form either of rostrum or of limbs which is proper to the fossorial habits of the psoric species, and that its facies is that of a plumicolous sarcoptid.

On *Passer domesticus* there lives, as there probably does on a number of other birds, a species which certainly belongs to the genus *Chorioptes* (Gervais) or *Symbiotes* (Gerlach); it is found at the point of insertion of the primary feathers, and does not seem to penetrate deeply into the skin; it is proposed to call it *C. avus.* On *P. domesticus* there is a very small *Pterotichus* which may be called *P. dermicola,* as it lives under the skin of the body.

Sarcoptes lævis.†—Prof. A. Raillet gives an account of a new acarid found parasitic on the pigeon and the fowl. This new species is very closely allied to *Sarcoptes mutans*, but appears to differ in having only one larva at a time; it is also smaller than *S. mutans,* though larger than *S. fossor;* it approaches the latter, and differs from the former species by the absence of cutaneous papillæ on the notogastrum of the female. The most important character, however, is the presence of two copulatory suckers on the male, for this is a very exceptional, though not unique, possession in the genus *Sarcoptes.* The mode of life of this new species shows that the name of plumicolous Sarcoptidæ is not exclusively applicable to the Analgerinæ, for *S. lævis* lives in the follicles of feathers. The author is of opinion that the presence or absence of copulatory suckers in a given form is not sufficient to justify the creation of a new genus, or even of a special section of an old genus.

Stage in the Development of Galeodes.‡—Herr A. Croneberg describes a somewhat remarkable stage in the development of *Galeodes araneoides;* the spherical abdomen forms the chief mass of the contents of the egg and the broad and flattened cephalothorax with the folded palpi, and the legs are pressed down on the lower surface of the abdomen. The appearance of young which have just escaped gives the impression of a contraction of the abdomen having driven part of the fluids contained in it into the anterior part of the body, the appendages of which have thereby become suddenly extended; the abdomen is now seen to be of an elongate egg-shape, and to have some slight constrictions. The cuticle is shown to be provisional by the complete absence of all the setæ and hairs which are so numerous in the adult; along the back alone is there a double row of twelve setæ. The appendages have as yet no distinct sign of segmentation, and there are no indications of the abdominal limbs. The rostrum is stout and broad, and is completely devoid of the complicated setal apparatus at its tip; the highly chitinized pharynx is provided with projecting chitinous ridges, and so calls to mind the structure of the Pseudoscorpions. Most remarkable is the presence of a pair of flat, wing-like appendages, about 0·5 mm. long, which are inserted on either side of

* Comptes Rendus, civ. (1887) pp. 921–3.
† Bull. Soc. Zool. France, xii. (1887) pp. 127–36 (1 pl.).
‡ Zool. Anzeig., x. (1887) pp. 163–4.

the cephalothorax in the space between the first and second pairs of feet; they are situated, however, very much higher than the feet, and there are no signs of them in the adult. It is difficult to say what these provisional organs mean, but they may perhaps be best compared with the paired appendages found in the embryo of *Asellus*. In *Galeodes* they are invested in a distinct cellular layer, which is altogether identical with the matrix of the general body-covering, but which does not contain tracheæ, nerves, or muscles.

As there was not, in the stage observed, any indication beneath the cuticle of the various appendages which are permanently connected with the skin, it is probable that the Galeodidæ live for a time in this pupal condition after escaping from the egg.

ε. Crustacea.

Parasitic Castration and its influence on the External Characters of male Decapod Crustacea.*—Prof. A. Giard has found that *Sacculina Fraissei*, which is parasitic on *Stenorhynchus phalangium*, so acts on the males as to give them very much the appearance of females; indeed, if one neglects to lift the caudal appendage and observe the position of the genital orifice there is some difficulty in determining the sex. Similar modifications were observed with young males of *Portunus holsatus* infested by *Sacculina Andersonii* (sp. nov.), and less considerable modifications were detected in other species. The Bopyridæ which infest young Decapods bring about similar results, and Perez has noticed a case of parasitic castration in the hymenopterous insects of the genus *Andrena* which is infested by *Stylops*. The author discusses the results arrived at, and comes to the conclusion that the modifications due to parasitic castration must be assimilated to those which are the result of progenesis—progenesis obtaining when sexual reproduction occurs in a more or less precocious manner, the products being matured before the creature has attained its full development.

In addition to their intrinsic interest the observations of Prof. Giard have an important bearing on the question of the value of the older statistics with regard to the Rhizocephala; the date of fixation of the parasite may be approximately fixed by the knowledge of the fact that the modification of the external sexual characters is the result of the profound lesion of the genital glands. The fact that a parasite provokes in its host an abnormal development of organs which protect it at the expense of its victim seems at first sight very exceptional, but it is to be regarded as a mutual adaptation which is not without analogy with numerous facts of symbiosis, while the deformations produced in various plants by the Cecidomyiæ or the Cynipidæ are phenomena of exactly the same kind; a curious case is that of the white campion (*Melandryum album*) which is infested by *Ustilago antherarum*; when the parasitic fungus is developed on a male plant it fructifies in the stamens, when it falls on a female the stamens, instead of remaining rudimentary, become completely developed just as the male *Stenorhynchus* widens its abdomen to protect the *Sacculina Fraissei*.

Palæmonetes varians.†—M. T. Barrois gives a careful account of the characters of *Palæmonetes varians* Leach, and discusses its geographical distribution. As to the somewhat anomalous characters of the latter the following explanation is offered; in earlier times the ancestors of existing

* Bull. Sci. Dep. Nord, x. (1887). Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 325–45.

† Bull. Soc. Zool. France, xi. (1887) pp. 691–707 (1 pl.).

lacustrine forms inhabited fjords and more or less deep bays which gradually lost their communication with the sea; the waters, which became less and less saline, were finally quite fresh, but they retained such of the animals as were able to adapt themselves to the new conditions of existence; it is because of this process that we find the same species in the sea as in fresh-water lakes.

Phylogeny of Bopyridæ.*—MM. A. Giard and J. Bonnier, limiting themselves for the present to European Decapoda, point out that each species of these Crustacea may have two or three distinct parasites; the Bopyridæ parasitic on the Decapoda may be divided into three groups—abdominal, branchial, and visceral parasites; analogous cases may be cited among the Branchiobdellidæ of the crayfish and the Œstridæ of deer and horses.

These facts, incomprehensible on the theory of the fixity of species, seem to show that several states of symbiotic equilibrium have been successively realized; by the aid of development these can be traced in the case of the Bopyridæ.

The first larva is very uniform throughout the group, and its long pelagic existence shows us that the ancestors of the Bopyridæ were free forms; by the whole of its organization it approaches the Œgidæ, and more particularly *Eurydice*. The second larva is of the *Cryptoniscus*-stage, and it is now that the parasitic life begins; in the Cryptoniscidæ the male is arrested in its development at the second larval stage, but in the other Bopyridæ it takes a more or less *Idothea*-like form.

The singular coexistence of parasitic Cirripedes in all the types of Decapods infested by the Bopyridæ leads us to suppose that the Bopyridæ have been introduced into the Decapoda by the Cirripedia Rhizocephala; while the members of one branch of the Cryptoniscidæ have remained faithful to their first host, another branch has become adapted for direct parasitism on the Decapoda, and has given rise to *Phryxus*, *Bopyrus*, and the Entoniscidæ. The presence of a phryxoid stage in the development of most female Bopyridæ shows that the genus *Phryxus* may be regarded as the stock whence many have issued.

Muscular Fibres of Edriophthalmata.†—Dr. R. Kœhler has investigated the mode of grouping of the contractile elements in the muscle-fibres of Isopoda and Amphipoda, as well as their relation to the cells from which they are developed. A large number of forms were examined. The contractile substance occupies the central region of the primitive bundle, while the protoplasm not differentiated into fibrils forms a peripheral envelope. It may form a layer more or less thick, but its situation in relation to the contractile element is always the inverse of that which is observed in the muscles of other animals. The variations in the different forms concern the size of the muscle-cells and primitive cylinders, the number of the cylinders, the form, development, and relative importance of the contractile element, and finally the number, size, &c., of the nuclei. The size of the muscle elements is not proportionate to that of the animal. As regards the above variations, Amphipods are much more regular than Isopods.

Copepod Parasite of Amphiura squamata.‡—M. A. Giard describes the female, male, and young forms of *Cancerilla tubulata* Dalyell, which he found at Fécamp as a very abundant parasite on *Amphiura squamata*.

(*a*) The female, which is generally fixed to the oral face of the disc, at the base of a ray, with its head towards the mouth, has a triangular form,

* Comptes Rendus, civ. (1887) pp. 1309–11.
† Journ. Anat. et Physiol, xxiii. (1887) pp. 113–23 (1 pl.).
‡ Comptes Rendus, civ. (1887) pp. 1189–92.

due to the presence of two egg-sacs as large as the body. The form and appendages are described.

(*b*) The male, which is much rarer and decidedly smaller, resembles a *Cyclops*. It differs markedly in the structure of the first and second thoracic appendages.

(*c*) Reproduction goes on from May to September; two or three egg-laden females may occur on one *Amphiura*; the segmentation is total and unequal; the gastrulation epibolic; the embryo a nauplius. The young forms fix themselves to the extremities of the arms of the *Amphiura*, and approach the disc as they grow.

In most of its characters, *Cancerilla tubulata* approaches *Ascomyzon echinicola* Norman, a parasite of *Echinus esculentus*, and *Asterocheres lillyeborgii* Axel Boeck, a parasite of *Echinaster sanguinolentus*. Its buccal armature connects the Pœcilostomata with the Siphonostomata, and M. Giard proposes to unite the Lichomolgidæ Kossmann (Sapphirinidæ Brady), the Ascomyzontidæ Axel Boeck (Artotrogidæ Brady), the Bomolochidæ Claus, and the Ergasilidæ Claus, in a single group of Coryceidæ.

Vermes.

α. Annelida.

Origin of Excretory System of Earthworms.*—Prof. E. B. Wilson, who has studied the development of *Lumbricus olidus*, finds a remarkable similarity between the development of its nephridia and the origin of the excretory system in Vertebrates. Of the eight large cells at the hinder end of the embryo two are nephroblasts; from each cell a row of cells extends forwards on the ventral side of the body; the rows are at first one cell wide, but become solid cords, several cells in thickness; in each somite a solid outgrowth from each nephridial row projects into the cœlom, and is ultimately converted into a nephridium; as these organs arise as metameric outgrowths from a solid cord of cells that lies in the somatopleure, their mode of development is essentially similar to that of the vertebrate pronephros. The nephroblast is originally an ectoblastic cell, and later sinks below the surface. Hatschek, Meyer, and Lang have called attention to the close resemblance between the Wolffian ducts of vertebrates and the longitudinal canal that unites the nephridia of the larval *Polygordius* and some adult annelids; the present results supply the embryological proof of the homology of the two structures, and show that the excretory system of annelids and vertebrates are constructed on fundamentally the same type, and originate by similar modes of development.

Polychæta of Dinard.†—M. le Baron de Saint-Joseph deals in this first portion of his memoir with the Syllidæ; in his introduction he speaks of the importance of examining Annelids in the living condition, pointing out that large species can only be preserved in alcohol, which destroys their colours and contracts their tissues, while all the media in which smaller forms are mounted have their inconveniences. The best—or, rather, the least objectionable—is Langerhans's fluid, which consists of five parts of gum arabic and five of distilled water, to which, after twenty-four hours, are added five parts of glycerin and ten of a five per cent. solution of phenic acid; before being put in this the worm should be plunged in a one per cent. solution of chromic acid, which kills it without causing so much contraction as alcohol.

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 49–50.
† Ann. Sci. Nat., i. (1887) pp. 127–270 (6 pls.).

Five different modes of reproduction are known among the Syllidæ:—(1) By direct reproduction, as in a number of forms. (2) By alternate generation and fission, and then by budding from a single stolon, as in *Syllis hamata*, *S. Krohnii*, and others; the stolones of the different genera always differ from the stock, and they differ also among themselves in the forms of their heads, of which there are four distinct types, that of *Syllis amica*, that of *Chætosyllis*, of *Tetraglene*, and of *Ioida*. (3) There may be reproduction by successive alternating generations, at first by fission with a single stolon, then by budding with a single stolon, and lastly by budding with several stolons in a chain, all the chains having for males the forms of *Polybostrichus*, and for females that of *Sacconereis;* here we find *Autolytus*, *Myrianida*, *Virchowia* (?), and *Procerastea* (?). Viviparous reproduction has been proved in two cases only, in *S. vivipara* and *S. incisa*. (5) Reproduction by lateral gemmation occurs in *Syllis ramosa*, where the stolones have the form of *Tetraglene*. There are as yet a number as to the mode of whose reproduction we are still ignorant. The descriptions of the species commence with that of *Syllis hamata*, under which must be included the varieties regarded by Czerniavsky as specifically distinct. *S. variegata*, *S. prolifera* are followed by *S. alternosetosa* sp. n. which is extremely common; its head is provided with four small eyes without a crystalline lens, the setæ are of various kinds, and remarkable for their complete alternation. *S. æsthetica* is also a new species characterized by the form of its setæ. Under *S. gracilis* Czerniavsky has distinguished four species, which must be united. *Pionosyllis* is accepted with the emendations of Langerhans. *P. longocirrata* sp. n. is distinguished by having the dorsal cirri of the anterior segments excessively long; transparent organs terminating in a cæcum surround the proboscis; the author is unable to ascribe any function to these long tubes, of which there are ten. *P. lamelligera* sp. n. is in some respects intermediate between *Pionosyllis* and *Eusyllis*, having, like *E. lamelligera*, the first ventral cirrus lamelliform and two glandular tubes attached to the sides of the proboscis. *Syllides longocirrata* is redescribed. *Eusyllis* is regarded as the bond of union between *Pionosyllis* and *Odontosyllis*, and nearer the former; the five species found at Dinard—*E. lamelligera*, *E. monilicornis*, *E. blomstrandi*, and *E. intermedia* sp. n.—are all fragile and phosphorescent. Four species of *Odontosyllis*, of which *O. polyodonta* sp. n. has a very large number of small teeth, are mentioned. The possession of a large conical tooth must be added to the definition of the genus *Trypanosyllis*, which is represented at Dinard by two species. *Pterosyllis spectabilis* is carefully described; this species often has its body and long dorsal cirri covered with *Trichodina Auerbachii*, and a curious marine infusorian which was described but not named by Claparède; it may be called *Ophryodendron annulatorum*. *Eurysyllis paradoxa* in its various stages is described.

Grubea clavata, *G. pusilla*, *Sphærosyllis hystrix*, and *S. erinaceus* are described. With regard to Langerhans's supposition that *Pædophylax* exhibits alternations of generation, Baron de Saint-Joseph expresses the opinion that the German naturalist based his view on animals which had lost their proboscis and proventriculus. Seven phases of *P. claviger* are described.

The genus *Autolytus* must include *Proceræa* and *Stephanosyllis;* the author gives an emended definition. *A. paradoxus* sp. n. is distinguished by having, from the third segment, the dorsal cirri alternately short and long. *A. longiferiens* sp. n. has an exceptionally long proboscis which is terminated by a crown of ten large obtuse teeth, separated from one another by three small pointed teeth. *A. ornatus*, *A. pictus*, and *A. macroph-*

thalma follow. *A. ehbiensis* sp. n. has a delicate body, and the proboscis is armed with thirty small equal teeth; it has been observed to reproduce itself either by a single male or female stolon, or by a chain of stolones. *A. punctatus* sp. n. differs from the last by having a double transverse row of small glands on each segment, and by the armature of its proboscis, which consists of twenty-four unequal teeth irregularly arranged; *A. lugens* and *A. edwarsi* are new species. *A. inermis* sp. n. is distinguished by the absence of teeth from its proboscis, while *A. megodon* sp. n. has a small number of well-developed teeth. A few words are said about *A. prolifer*. *Myrianida maculata* is fully described.

When one of the Syllidæ projects his proboscis the fleshy papillæ which precede it project from the mouth, and serve at first as a tactile organ; they then enlarge either to embrace a larger space, or to form a sucker, and then the arm which terminates the proboscis is darted rapidly once or twice, as the armed Nemerteans use their stylet. The author has often found adult examples without proboscis, proventriculus, or stomach; in place of these organs there was a duct like that which is found in sexual stolons, and the moniliform intestine commences at its usual spot. The cause of this irregularity remains for investigation. When the anterior part of the body is redeveloped the head and the regenerated segments are at first small and of the normal form, but the digestive canal is still a simple duct without proboscis or proventriculus; this was observed, for example, in *Syllis alternosetosa*, and *Odontosyllis fulgurans*.

In Syllids with direct reproduction the eyes increase very sensibly in size at the time when the sexual elements commence to ripen, and the natatory setæ to appear, just as in Nereids when about to take on the epitokous form. It would seem as if in those animals whose existence is specially precious there is a development of the organs which aid them in perceiving and escaping from danger; of the six eyes the two anterior appear to be rather pigment spots than optic organs.

A curious change of the muscular system obtains in the regions in which the natatory setæ are developed; the fibres increase in size and appear to become striated; a similar phenomenon obtains in the region of the remigerous setæ in Heteronereids. The canal of the teeth is very evident in *Pionosyllis longocirrata*, where it incloses a mass of small glands which are in communication with it and which seem to be poison-glands. Some Syllids have been observed (like a *Hesione*) to swallow water and even air. In *S. alternosetosa* it is effected in the following manner; the proboscis projects beyond the mouth, the proventriculus is distended transversely, and opening half-way along its median longitudinal line there is seen a delicate membrane, formed of circular muscles, which serves as an aspirator by causing a vacuum; the stomach is distended like the proventriculus, and the air and the water pass directly into the intestine; the two lateral gastric pouches appear to have the duty of containing the water; when they are closed their walls are distended and puffed out, and the vibratile cilia of their internal epithelium move very actively.

Organization of Chloræmidæ.*—M. J. Joyeux-Laffuie finds ten to fifteen specimens of *Chloræma dujardini* among the spines of a single example of the sea-urchin, *Toxopneustes lividus*. With regard to the numerous club-shaped prolongations, which have been hitherto regarded as parasites, they are probably, as Kölliker has suggested, tactile organs. The two tentacles in the cephalic infundibulum have internally a cavity which is divided into two by a delicate partition; with this branchiæform arrangement it is

* Comptes Rendus, civ. (1887) pp. 1377–9.

necessary to note that there is no blood-plexus, so that they are probably only accessory organs of respiration. The eye is not, as has been thought, formed by the union of two, but of four simple eyes arranged in cruciform fashion. Though the sexes are separated the gonads are similar in position and are best developed in spring and summer; at the reproductive period they attain a considerable size; the five pairs form elongated ovoid masses which float in the cœlom, and are merely held in place by a vessel which arises from the ventral trunk; the ovaries are of a greenish brown and the testicles of a light rosy colour. As the integument is thin enough for the gonads to be seen through it, it is easy to determine the sex of a living specimen.

Nephridia of Lanice conchilega.*—Mr. J. T. Cunningham gives an account of the nephridia of *Lanice conchilega* Malmgren, which, owing to their coalescence, present a condition which approximates to that of the excretory system of vertebrates. On dissection, four long double nephridial tubes are seen projecting dorsalwards, and examination shows that these tubes belong to somites 6–9. The lower parts of the efferent tubes are very wide, and cannot be separated from one another. In somites 10–13 there are membranous nephridial sacs, which, externally at least, are inseparable from one another; these sacs are simple, and appear to be devoid of a nephrostome. When a number of horizontal longitudinal sections were made, it was seen that the lower parts of the efferent limbs of the four anterior normal nephridia, and the whole of the succeeding nephridial sacs are in open connection, so that a wide continuous longitudinal tube extends from the sixth to the thirteenth somite. This is the first case in which communication between successive nephridia has ever been discovered in any adult invertebrate, and, though the presence of a metameric series of nephrostomata in vertebrate embryos has long been seen to constitute a resemblance between them and the Chætopoda, no Chætopod was known to resemble a vertebrate by having a number of nephridia coalesced to form a continuous longitudinal tube.

Criodrilus lacuum.—Dr. L. Oerley † gives an account of his morphological and biological observations on this incompletely known terricolous Oligochæte. It is a mud-worm 4–12 cm. in length, dark-brown or greenish dorsally, the body is quadrangular, and ends in a pointed yellowish, and often regenerated tail. There are from 200–250 or more somites; the four rows of setæ extend along the corners of the body; the genital organs are on the plan of *Lumbricus*, and present no peculiarities; the spermatophores are hornlike, and vary in number; each consists of a homogeneous, hyaline, mucous substance, in which a number of fine elongated filaments are imbedded. The bundles of spermatozoa are massed together in a spiral fashion. Nothing positive is known as to the time of sexual maturity, but Dr. Oerley is inclined to place it from March to the end of May. In no case did he find any trace of a clitellum, or of the so-called tubercula pubertatis; the male genital pore has a great glandular areola, and this appears to replace the clitellum. The cocoons are spindle-shaped, parchment-like structures about 5 cm. long; they change in colour in a way which reminds the author of the egg-cases of shark embryos, and, as in these, it seems to be due to chemical changes. The structure of the cocoon is described in detail. *Criodrilus* is to be found when the bottom of rivers is very nitrogenous, owing to the decomposition of organic matter; *Sium latifolium* appears to be its favourite plant. In the economy of nature

* Nature, xxxvi. (1887) pp. 162-3.

† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 551–60 (8 figs.).

they seem to do good service by their destruction of organic matter, while their fæces increase the goodness of the mud. Their power of regeneration is very remarkable.

Mr. W. B. Benham * has made this worm the subject of the third of his "Studies on Earthworms." The epidermis has but few mucous cells, and between its cells there pass blood-vessels as in the leech, *Perionyx*, and *Perichæta*. A considerable difference in appearance was detected behind somite XV. and extends to about somite XLVII., and the epidermis is there changed in character; in addition to the columnar cells of the general surface, there is a layer of elongated club-shaped cells, which have a very similar appearance to those in the clitellum of *Lumbricus* and *Microchæta;* another point of difference from *Lumbricus* is the absence of strands of connective tissue separating the club-shaped cells into more or less distinct groups. This clitellar structure appears to have been overlooked from its commencing and ending gradually, and from there being no difference of colour in the living worm. The nephridia-pores were not detected. From all other earthworms save *Pontodrilus*, *Criodrilus* differs in the absence of a gizzard; there is a moderate-sized typhlosole, contrary to the statement of Vejdovsky. The nephridia are not present in front of somite XIII.; in and behind it they are large organs, with a slight muscular vesicular portion. The seminal reservoirs are constructed on the plan of *Allolobophora;* the testes have a digitate form, and from their deep position are very difficult to find at first. The ovary is a flattened rounded disc, and the receptaculum ovorum, or, as Mr. Benham prefers to call it, the ovisac, is a botryoidal protrusion of the posterior septum of somite XIII. The author thinks that Dr. Oerley is mistaken as to the spermathecæ, as he was unable to find any trace of them, and it is suggested that the ciliated rosettes were mistaken for them. The worm should be looked for in this country.

Sig. D. Rosa sums up † the principal facts observed in his researches on *Criodrilus lacuum*, especially those relating to the genital organs, of which he enumerates the parts and indicates the position relative to the segments.

From his researches the author arrives at the following conclusion: "*Criodrilus* has its nearest relations in the Allolobophora (*A. turgida* Eisen, &c.); it belongs to the same *phylum* of the true *Lumbricidæ*, of which it is an extremely modified form."

He proposes to create a sub-family Criodrilinæ of the family Lumbricidæ.

Anatomy of Priapulidæ.‡—Dr. H. Schauinsland has continued § his studies on *Halicryptus* and *Priapulus*. The central nervous system lies altogether in the ectodermal epithelium. Although it is not in any way distinctly segmented, yet there are indications of segmentation. In the regular interspaces which lie between the separate bundles of circular muscles, there is a greater aggregation of ganglionic cells than in the rest of the course. Just in front of the division of the œsophageal ring there are three ganglionic masses, which correspond to the subœsophageal ganglion of Annelids. Peripheral nerves are given off from the sides of the nerve-cord along its whole course, a larger number being, of course, given off from the ganglionic swellings than from elsewhere. This intensifies the impression of a commencing metamerism of the nervous system. The peripheral nerves never form a completely closed ring, as they are said to do in *Sipunculus*,

* Tom. cit., pp. 561–72 (11 figs.).
† Boll. Mus. Zool. e Anat. Comp. R. Univ. Torino, i. (1886) pt. 15.
‡ Zool. Anzeig., x. (1887) pp. 171–3. § See this Journal, *ante*, p. 91.

but soon break up into fine nerve-fibres, which course in various directions, forming at last a plexus of the finest nerve-fibrils. The whole arrangement of this terminal nerve-plexus agrees in almost every detail with the epidermal plexus of the peripheral nervous system of *Sagitta*.

The plexus is especially thick in the region of those peculiar dermal structures which so richly cover the body of *Halicryptus*, and these, therefore, may be definitely regarded as tactile organs. True unicellular glands are found abundantly among the epidermal cells, just as in Oligochæta. The intestine has a longitudinal and a circular layer of muscles, while just beneath the epithelium there is a layer of very fine muscular fibres, which extend in all directions. They agree in structure with those of the body in forming a tube which is filled with protoplasm, and has walls formed by fine fibrils. The enteric epithelial cells are extraordinarily long, and have at their upper ends a knob-like swelling, with a fringe of very short and fine cilia. The whole wall is traversed in all directions by a system of very fine canaliculi, which have, perhaps, the function of chyle-vessels. Among the cœlomic corpuscles some are small and livelily amœboid, and others larger and non-amœboid. They appear to be derived from the numerous amœboid connective-tissue cells, which are not only able to move about among the tissues, but to pass into the cœlom. Between these and the small forms there are various intermediate stages. It may be remembered that Kukenthal found the same mode of origin for the lymphoid cells of Annelids.

β. Nemathelminthes.

Process of Fertilization in Ascaris megalocephala.*—Dr. O. Zacharias has made use of some new methods of investigation for the purpose of studying the finer processes in the fertilization of the egg of *Ascaris megalocephala*, as he suspected that Nussbaum and van Beneden had had to do with injured ova. By this new method, in which he successfully hardens the ova in two hours, and preserves them without any shrinking of the yolk, he has been able to obtain a series of the intermediate stages in the formation of the pronucleus which were as yet wanting. The results agree with the theory of O. Hertwig as to the fusion of the genital products, and give a fresh support to it. What Prof. E. van Beneden took for pronuclei are reported to be already conjugated nuclei. A full account of the results is promised.

Revision of the Gordiidæ.†—M. A. Villot discusses and describes nine of the species of the genus *Gordius*. Four of these—*G. affinis*, *G. alpestris*, *G. gemmatus*, and *G. Bouvieri*—are new. The last named is alone an exotic form; all the rest were collected in the neighbourhood of Grenoble.

The author expresses his dissatisfaction with most of the descriptions of preceding authors. The variations in length and breadth are so great that these characters must not be supposed to have any specific value. The coloration of the integument depends on the extent to which chitinization has proceeded; in all species young individuals are of a uniform milk-white colour, and the females are always less deeply coloured than the males, and after the deposition of ova their integument has almost always the transparency of glass. The possession of a buccal orifice, and the division of the body into rings are youthful characters, of which no traces are left in old individuals. The form of the two extremities is really of specific importance, but even here attention must be given to the age of the specimens. The bifidity of the caudal extremity of the males is a sexual character, and

* Zool. Anzeig., x. (1887) pp. 164–6.
† Ann. Sci. Nat., i. (1887) pp. 271–318 (3 pls.).

is probably of generic importance. The microscopic study of the peculiarities of the cuticle is, as the author showed in 1873, a very important aid to the discrimination of the species, and this has been recognized by later writers, and especially by Oerley; the author points out the care which is to be taken in making use of this method of investigation.

Under *Gordius aquaticus* the names of eight other "species" are included. Its variability may be judged of from this fact alone. This species is very fully dealt with in a useful and exhaustive manner. Of *G. alpestris* the author has only as yet been able to obtain male specimens. In *G. tolosanus* the epidermis presents both specific and sexual characters, for in the males the large hemispherical areolæ have a large pore at their summit. This species has been once found in the human intestine. The species is most often found free at the end of the month of June. *G. affinis* is based on a single female specimen, but its cuticular characters are sufficient to distinguish it. Some additions and corrections are made to Baird's description of *G. pustulosus*. *G. gemmatus* is the sole representative of a distinct group of the genus. *G. violaceus* has probably often been confounded with *G. aquaticus*. It is an error to suppose that the trilobate character of the hinder extremity of *G. gratianopolensis* is a good specific mark of distinction. *G. bouvieri*, from an unknown locality, is distinguished from the indigenous forms by its large size.

Filaria inermis.*—Prof. B. Grassi gives a description of a new species of *Filaria* which has been found in man, the horse, and the ass. The female, which alone is known, is about 16 cm. long, and appears to be much broader (475 μ) than thick. The specific name of *inermis* is due to the absence of teeth. The first example was found in a woman in the province of Catania, and was sexually immature. A specimen was found in the eye of the ass. Other examples were found in the eye of a man, and in horses (organ ?), in Mailand. According to the system of Molin, this new species falls into the section Acheilostomi, and appears to be allied to *Filaria perforans*, which differs from it by having the posterior extremity "valde attenuata." The author thinks that the *F. peritonæi hominis* of Babes is identical with his species.

Muscular Fibres of Echinorhynchus.†—In regard to the disputed import of the longitudinal lateral bands projecting internally on the wall of *Echinorhynchus gigas*, M. R. Kœhler corroborates the observations of Schneider, and maintains that they are sack-like expansions of the circular fibres. The relations of the muscle-fibres in *E. heruca* are of importance in this connection, and are described. The two longitudinal bands are not homologous with the lateral bands of *E. gigas*, but arise from the enlargement of the cells in which the longitudinal fibres are developed. In regard to the large number of nuclei found in the muscle-cells of most *Echinorhynchi*, but in small proportion in *E. gigas*, M. Kœhler suggests that each fibre corresponds to a cell, and that the muscle-nuclei are conserved in the bands, while they have disappeared in other regions of the body.

Morphology of Muscular Fibres in Echinorhynchus.‡—M. R. Kœhler, in a subsequent paper, describes the muscular fibre in *Echinorhynchus heruca*, *E. proteus*, and *E. gigas*. In the first of the three species the large muscle-cells of the circular layer each consists of an internal unmodified portion of protoplasm, with a nucleus, and an external contractile portion containing a large number of fibrils. In the longitudinal layer the fibrils

* Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) pp. 617–23.

† Comptes Rendus, civ. (1887) pp. 1192–4. ‡ Ibid., pp. 1634–6.

form three or four groups in each cell, each group constituting a tubular fibre. In *E. proteus* each muscle-cell incloses a much larger number of groups of fibrils, imbedded in unmodified protoplasm; the cells are larger than in the previous species, and there are fewer of them. In *E. gigas* the cells are enormous, and each incloses an infinite number of groups of fibrils, forming complicated fibres, surrounded by unmodified protoplasm.

The transverse muscle-cells of *E. heruca* have the value of primitive bundles, those of *E. proteus* have a lower morphological value, though still portions of primitive bundles, and this value is still less in *E. gigas*.

He draws attention to similarity between the muscle-cells of *Ascaris* and those of *E. heruca*, but considers that the two groups are not closely related.

γ. Platyhelminthes.

Stichocotyle nephropis.*—Mr. J. T. Cunningham describes a new form of Trematode found parasitic in the intestine of the Norway lobster—*Nephrops norvegicus;* there is as yet no evidence as to how the fluke reaches the intestine of the lobster; in it they are found encysted; the other host is probably some large fish which feeds on *Nephrops.* It is a typical Trematode, remarkable, however, for the arrangement of the suckers, which is entirely novel; they form a single series extending along the median ventral line throughout nearly the whole length of the body, and, unlike forms to which it may be allied, the suckers are not provided with chitinous hooks. *Stichocotyle* may be placed with the Polystomidæ, though it differs from all known forms in passing through an encysted stage within the body of another animal. The cyst appears to be a pathological product of the tissue of the intestine of the host. The worms are from 0·75 to 8·6 mm. in length, white in colour, and somewhat opaque; the mouth is small, simple, and circular; the suckers present some of the characters of metamerism. The presence of closely-set transverse folds gives the body a crenated figure; these folds disappear when the body is much extended, and are probably due to the presence of an inelastic cuticle.

New Trematode.†—Dr. J. Brock describes a new genus of Trematode —*Eurycœlum shuteri*—which he found abundantly in the stomach of a Percoid—*Diacope metallicus.* The body has an elongated cylindrical form, slightly pointed anteriorly and posteriorly, with a small oral, and much larger approximately median sucker. The germinal glands are not always, but only temporarily connected with the efferent ducts. The connection of testes and vesicula seminalis is notably transitional. The yolk-glands are elongated sacs, occupying an asymmetrical dorsal position. They are not connected with the oviduct or shell-gland till the period of female maturity. Nor does the uterus acquire an external aperture till a late stage. There is no common generative atrium. Although the uterus remains blind during most of the female maturity, and there is no communication with the male organs, both its proximal portion and the oviduct contain very early abundant sperms which fertilize the ova. The possibility of self-fertilization or of cross-fertilization is obviously excluded. The third alternative remains of a communication viâ Laurer's canal. This was not, however, demonstrated. The longitudinal stems of the excretory system are so wide that they must be called spaces rather than canals, and look like the beginning of a body-cavity.

Ciliated Pits of Stenostoma.‡—Herr B. Landsberg has found the pyriform ganglia discovered by Vejdovsky at the base of the ciliated pits of

* Trans. Roy. Soc. Edinb., xxxii. (n.d.) pp. 273–80 (1 pl.).
† Göttingen Nachrichten, 1886, pp. 543–7. ‡ Zool. Anzeig., x. (1887) pp. 169–71.

some species of *Stenostoma*. To examine them in section cuts must be taken in an oblique direction through *S. leucops*. The base of the pits is covered by a pretty thick layer of uncoloured homogeneous substance, which may be regarded as mucus; below this is a thin layer of ciliated epithelial cells, and there then follows a thicker layer, which consists largely of pyriform cells, but also of other histological elements; only one nerve reaches close to the pits, where it divides and gives off a branch to each little pit; this is shown to be sensory by its investment with very small ganglion-cells. Teasing revealed the presence of bi-polar and some multipolar ganglion cells, the processes of which form plexuses, ciliated epithelial cells of various sizes, partly membranous cells which have an investing function, goblet-like mucous cells, muscular fibres which cut the plexuses at right angles, and special cells, which may perhaps be regarded as sensory; these last are rounded or oval, have a distinct nucleus and nucleolus, and are on one side drawn out into a pencil-like process, and on the other continued into a fine fibre.

Distoma endemicum.*—Prof. I. Ijima has found that the form first described in 1883 by Prof. Baelz as *Distoma hepatis endemicum* is found not only in man but also in cats in Japan. The latter fact makes it easier to trace the history of the fluke, but the author has not yet been able to determine what inhabitant of the ditch-water it is into which the ciliated embryos pass for an intermediate host. He doubts whether Baelz is right in supposing that the parasites return to man in ditch-water, and suggests that more worthy objects of suspicion are (1) *Paludina* and *Corbicula*, though these are never eaten in a raw condition, (2) vegetables which have been washed with ditch-water, or (3) a second intermediate host, such as shrimps or various fishes.

The parasite, when fresh, is translucent; the body is about 11·75 mm. long, and its greatest breadth is from 2–2·75 mm., so that it is not unlike *D. lanceolatum* in shape; the "brain" forms a bridge over the œsophagus, and does not lie, as is usual, above or in front of the pharynx. What has hitherto been taken for the ovary is a contracted mass of spermatozoa. The ova are unusually small, and the embryos are of an elongated oval shape, 0·025 mm. long; there are no eye-spots.

Land Planarians.†—Dr. D. Bergendal has a preliminary notice of his investigations on *Bipalium kewense* which has been found in the orchid-houses of the Botanic Garden at Berlin. Referring to the question of multiplication by transverse division, as to which it will be remembered Prof. Bell made some observations to the Society last year,‡ the author states that he has never been able to find sexually mature specimens, though in one case sections showed small aggregations of cells which might be regarded as rudiments of testes. Spontaneous transverse division was three times observed in forms from which pretty large pieces had been cut off at the anterior end; the large quantity of small pieces which were found in the hot-houses are, of themselves, sufficient to show that the phenomenon is not very rare.

The excretory vascular apparatus consists of a ciliated funnel with a very strong "flame," irregular or plexiform canals, and longitudinal trunks. The last undulate slightly, and two or more are found dorsally and laterally to the enteric branches; there are also ventral longitudinal trunks. All consist of large cells, and have thick cilia, the papilliform basal portions of which give a plexiform appearance to the walls. From these long trunks

* Journ. College of Science Imp. Univ. Japan, i. (1886) pp. 47–59 (1 pl.).
† Zool. Anzeig., x. (1887) pp. 218–24. ‡ This Journal, 1886, p. 1007.

transverse straight canals are given off, which may partly serve as efferent, and partly as collecting canals. The long canals lie so deeply in the parenchyma, that it is hardly possible to observe them except in sections. The plexiform canals and the ciliated funnels must, however, be studied in living tissue; the latter are connected with the former by canals of varying length in which there seem to be no cilia.

The nerve-trunks vary in structure in different parts; the longitudinal trunks are connected by transverse commissures which are very thin, and often branch; the author was also able to detect these commissures in specimens of *Bipalium Diana.* In addition to these there are strongly arched nerves, which form a plexus under the skin, which is best developed on the head and in the anterior part of the body; the ganglionic cells are large, and have very large nuclei, with two or three processes. The longitudinal nerves are connected with one another at the hinder end of the body. In the cephalic region there is a flattened brain, the formation of which is clearly due to the union and increase in size of the longitudinal trunks; from this region strong nerve-branches pass to the pits found at the anterior end; the nerve-fibrils are thick, and give off from their ends fine prolongations which extend outwards between the cells of the epidermis. Eyes are present in large numbers, and form a zone three or four rows deep at the margin of the head; they are also found at the sides of the body as far as its posterior end. The largest eyes lie just behind the head. In structure they agree closely with those of the other Triclades, and they are supplied with nerves from the superficial plexus; in some cases a ganglion-like swelling was noticed at the sides or in front of the eyes.

The whole body is provided with cilia; between the ordinary epithelial cells there are here and there groups of more delicate, rod-like cells, which may possibly be sensory organs; the rhabdites are mostly small and spindle-shaped, but not a few are filamentar and more or less rolled on themselves; both kinds are found in the same cell.

In *B. Diana* an encysted Nematode was observed, and in the unpaired exterior branch there was a gastropod radula. Fuller accounts with illustrative figures are promised.

Function of Uterus or Enigmatic Organ in Fresh-water Dendrocœla.* M. P. Hallez appears to agree with Ijima in thinking that the function of the so-called uterus of fresh-water dendrocœle planarians is that of a gland which secretes the substance that forms the envelope of the cocoon. The organ called enigmatic by O. Schmidt, and muscular glandular organ by Ijima, appears to M. Hallez to act as a pump or piston which drives into the cloaca the male elements; and it is not impossible that it also serves to distribute the fertilized ova, and to expel the cocoon. *Planaria polychroa,* which is without this organ, has muscular fibres in the cloaca and near the orifice of the uterine canal; these appear to take the place of the absent organ.

In the rhabdocœlous planarians, and especially in *Vortex*, there is an organ which appears to be similar to the enigmatic organ; it is known as the bursa copulatrix, and the same name might well be applied to the organ in the Planariæ.

δ. Incertæ Sedis.

Balanoglossus Larva.†—Mr. W. F. R. Weldon describes a larva, not unlike that described recently by Mr. Bateson, which has, however, a very different history. After the development of the gill-slits there appears to be

* Comptes Rendus, civ. (1887) pp. 1529–32.
† Proc. Roy. Soc. Lond., xlii. (1887) pp. 146–50.

much variation in the conduct of the larvæ; some exhibit indications of a normal development, but the majority undergo a gradual process of degeneration, accompanied by considerable increase in size; the proboscis cavity becomes smaller, its wall thinner, and its muscles fewer; the notochord, collar cavities, and gill-pouches disappear; the ectoderm becomes much thinner, and the greater part of the nervous system disappears. This larva was observed at Bemini, Bahamas. A little later, a much larger larva, found at Nassau, New Providence, was found to undergo still further degradation, the ectoderm over the greater part of the body becoming a mere flattened epithelium, the trunk cavity a minute solid rod, and the proboscis cavity much further reduced than in the Bemini larva.

The cause of this degradation is probably the compulsory shifting of the larvæ into deep water; if this be admitted it follows that, in some cases at least, the transmission by a larva of hereditary changes is only possible on the application of certain stimuli, that where these are wanting, some larvæ are highly variable, that the variations due to change in environment may be uniform and definite, and that the changes may result in the hypertrophy of the larval organs.

Trichodina paradoxa.*—Prof. H. Ludwig has a note on the remarkable parasite of the Firolidæ, lately described by M. Barrois,† showing that it is nothing more than the separate capitulum of a gemmæform pedicellaria, and almost certainly of *Sphærechinus granularis.*

Echinodermata.

Mergui Ophiurids.‡—Prof. P. Martin Duncan has a report on the thirteen species of Ophiurids collected by Dr. J. Anderson in the Mergui Archipelago; of these nine are new and one is the representative of a new genus—*Ophiocampsis*, which is placed near *Ophiothrix;* this form is able to bend its arm in a vertical downward plane and has no upper arm-plates. In a succeeding contribution,§ the author deals with some points in the anatomy of *Ophiothrix variabilis*, and *Ophiocampsis pellicula;* as to the latter, the opposed surfaces of the arm-bones are remarkable, particularly because of the enormous upper muscle-area on the aboral surface of the arm-bones, and the "peg" is absent; there are no knobs on the adoral surface, while the large size of the slot and the obliquity of the apophysis allowed of great downward bending as well as of lateral movement. Especial attention is given to the arrangement of muscles in *Ophiothrix*, and it is clear that the development and distribution of muscles is not the same among all Ophiuridæ. With regard to the subsequent term "chewing apparatus," the author points out that the arrangement of the jaws does not admit of chewing, though the process of filtering occurs.

Cœlenterata.

Chromatology of Anthea cereus.‖—Dr. C. A. MacMunn has found chlorophyll as well as chlorofucin in extracts of the "yellow cells." If sections of the tentacles are made after hardening in alcohol the mass of yellow cells are found packed in the tentacle at random as it were, and it seemed to be quite clear that these bodies are not secreting cells. The chlorophyll of *Anthea* differs from other chlorophylls in its remarkable instability towards caustic alkalies, and the chlorofucin which accompanies

* Zool. Anzeig., x. (1887) pp. 296–8. † See this Journal, *ante*, p. 373.
‡ Journn. Linn. Soc. Lond., xxi. (1887) pp. 85–106. § Ibid., pp. 107–20 (4 pls.).
‖ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 573–90.

it is also remarkably unstable. Precisely the same colouring matters are present in the tentacles as in the rest of the animal, and as those in the tentacles are due to yellow cells it is fair to conclude that those of the latter have the same origin, and do not belong intrinsically to the animal. The author cannot accept Krukenberg's view that the colouring matters of *Anthea* are allied to "hepatochromates," because enterochlorophyll is not nearly so easily decomposed as are the pigments of *Anthea*, and they are at once distinguished by Stokes's fractional method.

North Sea Alcyonida.*—Dr. D. Danielssen finds that the Alcyonids collected by the Norwegian North Sea Expedition of 1876–8 are exclusively deep-sea forms; nine new genera belong to the Alcyonidæ, in addition to which there are two new species of *Clavularia*, one of *Sympodium*, one of *Nidalia*, and a new genus and species representative of a new sub-family—that of the Organinæ. With regard to the anatomical and histological details, the most important appear to be:—the discovery in *Væringia mirabilis* of a group of large ganglion cells on the uppermost part of the ventral surface of the gullet; these have a prolongation rich in protoplasm, and under them there are smaller, round, pellucid cells and extremely slender fibrils; unfortunately, the condition of the specimens did not permit of these interesting indications being more completely investigated. In all the species examined the œsophagus had, on its inner ventral surface, a groove coated with long flagelliform cells; in *Gersemiopsis arctica* g. et sp. n., the channel is divided longitudinally so that the gullet groove forms the true œsophagus, and the remaining part may be regarded as an intestine. The œsophagus is richly supplied with unicellular mucous glands, which were also found in great abundance on the outer surface of the polyps of all the species examined. It does not appear that there is no division of labour in the colonies of Alcyonids, for in *Nephthys* several species were found to have special reproductive polyps; and as soon as the elements are matured the tentacles become curved in towards the oral aperture, which becomes closed by a viscid mucous; the gullet-tube becomes converted into a uterus, in which development proceeds, and during this period such polyps are nourished by others of the colony.

Of the new genus *Væringia* there are nine new species; of *Duva* eight; of *Drifa* two; of *Nannodendron* one; of *Fulla* one; of *Gersemiopsis* one; of *Barathobius* one; of *Sarakka* one, and of *Krystallofarces* one. The new sub-section Organinæ has the zoanthodem poor in sarcosoma, the polyp-cells are long and so arranged as to give to the whole structure somewhat of the appearance of a collection of organ-pipes; the new genus *Organidus* has its single species dedicated to Baron von Nordenskjöld. The plates are as beautiful as in preceding memoirs of this series.

Porifera.

Systematic Position and Classification of Sponges.†—Dr. R. von Lendenfeld makes use of the nomenclature of the spicules recently established by Messrs. Sollas, Ridley, and Dendy, but it is incomplete in so far as the proposals of Prof. Sollas have been only partly published as yet.

With regard to the systematic position of the Sponges, the view that they ought not to be included among the Metazoa is rejected; they are Cœlentera in the sense that the Cœlentera and Cœlomata make up the Metazoa; from what are ordinarily called Cœlenterata (Nematophora or

* Den Norske Nordhavs Expedition, 1876–8, xvii. Alcyonida. 4to, Christiania, 1887, v. and 169 pp., 23 pls., 1 map.

† Proc. Zool. Soc. Lond., 1886 (1887) pp. 558–662.

Cnidaria) they are sharply distinguished; while the Cœlenterates may be called Epithelaria, the Sponges are Mesodermalia; the latter may have, the former never have, a branching canal system. With regard to their tissues, the Mesodermalia have invariably simple ectodermal and endodermal epithelia, the cells of which are always flat pavement-cells, and are never converted into muscular, glandular, sexual, or sensitive elements; such elements are in Sponges invariably modified cells of the mesoglœa; the Epithelaria, on the other hand, have a mesoglœa, the cells of which remain more or less amœboid, and are not differentiated to any extent. The muscular, glandular, sexual, and sensitive cells are produced in the epithelia, sinking below the outer cell-layer with advancing development, and lying on the surface of the mesoglœa or supporting lamella. A phylogenetic table and a systematic classification follow.

With regard to the classification of Sponges, Dr. v. Lendenfeld regards the composition of the skeleton as affording the first basis; those in which the skeleton is composed chiefly of carbonate of lime form the subclass Calcarea, and those in which it is originally composed of siliceous spicules are the Silicea; in the former there is the single order of the Calcispongiæ, while the latter are divisible into (1) Hexactinellida, where the mesoglœa is soft, and the supporting skeleton is often strengthened with siliceous cement; the spicules are triaxial; (2) Chondrospongiæ, where the mesoglœa is hard, the toughness being due to the hardening of the ground-substance; the spicules are tetraxonial, monaxonial, anaxonial, or absent: in (3) the Cornacuspongiæ, the mesoglœa is soft, the supporting skeleton is strengthened by spongin cement or exclusively formed of spongin, with or without foreign bodies; spicules are monaxonial or absent. A systematic table is followed by a key to the recent families of Sponges, and a compendious bibliography completes the paper.

Relationships of the Porifera.*—Dr. G. C. J. Vosmaer accepts Gray's division of the Sponges into Calcarea and Non-Calcarea; the latter class is divided into Hyalospongia (= *Hexactinellidæ* of authors), Spiculispongiæ, and Cornacuspongiæ; though we do not know of any direct transition from the first to the other two orders, yet there are certain indications among many already known facts, and the author states that he has found many sponges in which there are a few rudimentary six-rayed spicules lying among the normal ones.

The hypothesis that Sponges are Cœlenterates is not accepted; arguments against the degeneration-idea of Marshall are brought forward, and it is urged that the central cavity of sponges is in no way a gastric cavity; the argument from development is distinctly against the Cœlenterate affinity of sponges.

"If we accept a free-swimming form as the ancestor, and suppose further structures become secreted in certain cells (thereby conferring an advantage in rendering these delicate forms of life less subject to fall a prey to other animals), then we must at the same time believe that in one group calcareous, and in another siliceous matter was developed. But this new development led to the restriction, nay, finally, even to the complete prevention of free movement, and thereby a higher animal development was precluded. Sessile animals must develope in a special direction in order to maintain the struggle for existence. Nutrition and respiration must be assured; hence, though the degree of development is a low one, yet a well-developed canal-system has been formed."

* Vosmaer, 'Porifera' in Bronn's Klassen u. Ordnungen, ii. pp. 472–81. See Ann. and Mag. Nat. Hist., xix. (1887) pp. 249–60.

Dr. Vosmaer believes that the oldest sponges were deep-sea forms, and that a consequence of their living in shallow regions has been an arrest of development, the skeleton degenerating and the variety of spicular forms being gradually reduced.

The most primitive forms of the Calcarea were, possibly, Olynthus-like; these gave rise to the Asconidæ and the ancestors of the Syconidæ, as well as to the Leuconidæ and Teichonidæ. The primitive form also gave rise to the Siliceous Sponges with triaxonid spicules; thence the Hyalospongiæ and the Tetraxonina. The hyalospongine stock gave rise to the Lithistina, Geodidæ, and Ancorinidæ; from the last arose the Plakinidæ and Corticidæ, and doubtless also the Chondrosidæ and Halisarcæ; the main stem degenerated and gave rise to the Halichondridæ; the appearance of spongin rendered spicules superfluous, and thus appeared progressively the Spongidæ, Aplysinidæ, and Darwinellidæ.

Reproductive Elements of Spongida.*—Mr. H. J. Carter has an essay on the reproductive elements of sponges, in which he gives some information as to the structure and position of the ovum in *Chondrosia spurca*, and the history of some of the discoveries connected with this subject.

Protozoa.

Biology of Astasia ocellata and Euglena viridis.†—M. W. Khawkine finds that *Astasia ocellata* sp. n. and *Euglena viridis* resemble one another in each being a naked cell of almost the same form and size, whose body is composed of ectoplasm and endoplasm. The former is a closed sac of elongated form (fusiform, or acutely or conically cylindrical), with a small orifice at its anterior end which leads into a pharynx; one flagelliform filament is attached to one of the walls of this canal. This sac is impregnated to a certain extent with elements which do not undergo putrefaction, and according to the forms of contraction, we may attribute to it a muscular structure, the fibrils being disposed in a manner suitable to independent contraction. The form and disposition of these fibrils are not the same in the two organisms; in *Euglena viridis* they are longitudinal and annular, and the latter are only found in the anterior part of the body; *Astasia ocellata* has annular fibrils only, and they extend from one end of the body to the other. The endoplasm of *Astasia* is characterized by the thickness of its consistency and by its immobility, and this appears to be the cause of the diversity of its form in various stages of development; in *Euglena*, the endoplasm is less compact, and changes its place more easily; but in this point various species of *Euglena* differ. In both forms there is a nucleus, nucleolus, and accessory elements; the last, in *Astasia*, being limited to small granules, which appear to be the organs that elaborate the grains of paramylon; *Euglena viridis* has none of these small granules, and the grains of paramylon depend either on the plasma (or chromatophores), which are situated at the centre of the body. Here, again, *Euglena* presents some variations, for in some the part in question is single, in others double, and in yet others the grains of paramylon appear notwithstanding its absence. Like all colourless protoplasm, that of *Euglena* and *Astasia* is easily able to appropriate to itself assimilable organic products; this process, as well as the contrary one of waste, obtains more largely in the endo- than the ectoplasm, and provokes, during abundant nutrition, an unstable equilibrium and a positive pressure between the contents and the surface. In periods of famine there is a "vegetative pressure" between

* Ann. and Mag. Nat. Hist., xix. (1887) pp. 350–60.

† Ann. Sci. Nat., i. (1887) pp. 319–76 (1 pl.).

the parts. In the former case, the result is that the organism divides into two; the process of division is effected in the same way in both forms.

As is well known, *Euglena* may be distinguished from *Astasia* by the possession of this chlorophyll, and to this we must ascribe the differences which are to be observed between the vital functions of these two organisms; these differences are—(1) that the chromatophores present the source of an abundant nutrition by means of inorganic elements, and (2) one of the products is a considerable quantity of mucus which exudes by the walls of the body.

Thanks to the first circumstance, *Euglena* appears to be accustomed to this kind of inorganic food to such an extent that deprivation is distinctly felt, though it is not fatal; in darkness, *Euglena*, unlike *Astasia*, does not seem to be able to undergo free division, but invests itself in a solid impermeable cyst. The second circumstance, the abundant secretion of mucus, leads, in ordinary division, to the immobile state, and the formation of complex groups; two facts which play an extremely important part in the life of the *Euglena*, and which are, if not the sole, yet the most important cause of the great difference in the numerical propagation of the two forms. *Astasia*, spending all its life in movement, has but little left wherewith to reproduce itself; *Euglena*, on the other hand, leads a quieter life. The mucous coverings of *Euglena* defend it from cold, heat, and evaporation, enemies, and the effects of an insufficient supply of food, while, when they form themselves into a connected mass, the ciliate Infusoria, which prey on them when they are single, are unable to attack them. *Astasia*, on the other hand, cannot form either colonial groups or united membranes, and so, in the struggle, has one important weapon the less.

As all these facts are due to the presence in one and the absence from the other of the chromatophores, these appear to be the sole essential character which distinguishes *Astasia* from *Euglena;* the one is an *Astasia* provided with chromatophores, the other a *Euglena* devoid of them; in fact, we may put our present knowledge thus:—If the Chitridiæ, which glide into the *Euglenæ* and first devour the chromatophores, were to leave without doing any other harm, there would be an organism identical with *Astasia* in all its essential characters and functions. Were this to happen, the *Euglena* would have to learn to be content with organic nutriment; indeed, the advantage in the struggle for existence that *Astasia* now has, is, that it can take assimilable organic nutriment which contains force-stuffs already made.

New Peridinian.*—M. J. Danysz describes the structure and life-history of a new Peridinian (*Gymnodinium musæi* n. sp.) found in the Jardin des Plantes. The flattened ellipsoidal form, the absence of cuticular envelope; the transverse groove dividing the body into two unequal parts, obliterated, however, at the middle on one side; and the presence of an irregular prominence at this point, bearing the superficial, red, ocular spot and the two flagella, are characteristic features.

The reproduction of *G. musæi* occurs (*a*) by means of successive divisions, (*b*) followed by the formation of spores—the result of the fusion of two individuals of minimum size. During July and August the development of an individual is complete in fifteen days, but in favourable conditions this may be much accelerated.

Peridinea.†—M. G. Pouchet communicates a fourth contribution to the history of the Peridinea. After a general introduction, in which he dis-

* Arch. Slav. Biol., iii. (1887) pp. 1–5.
† Journ. Anat. et Physiol., xxiii. (1887) pp. 87–112 (2 pls.).

cusses the history of research bearing upon these interesting forms, the author describes at length the genus *Gymnodinium*, with the species *G. helix* Pouchet, *G. polyphemus* var. *roseum*, *G. polyphemus* var. *nigrum*, *G. musæi*, Danysz, *G. punctatum* Pouchet; and further, *Polykrikos auricularia* Bergh. The latter inclosed in more than one instance a remarkable ovoid body, which presented all the appearances of an ovum.

Hæmatozoa of the Tortoise.* — Prof. B. Danilewsky communicates a further account of the minute parasites found in the blood-corpuscles (Hæmatozoa, Cytozoa, &c.). The present research gives an account of the form and structure of that found in the blood of *Emys lutaria*. The appearances of forms of various age and size, their influence on the blood-corpuscles, and other facts are discussed at length.

In a second paper,† the author describes the general biological characters of the parasite, its movements, relation to reagents, number, geographical distribution, and the like.

As regards its position among similar forms, the adult presents many close resemblances to *Drepanidium ranarum* and *avium*. The presence in the tortoise of gregarinid spores with falciform germs identical with the hæmocytozoa, suggests affinity with the Gregarinida. The size, simple constitution, single vesicular nucleus, characteristic movements and mode of life, all support this conclusion, but there can be little doubt that the form described really represents an adult. Danilewsky therefore refers it provisionally to the Monocystid Sporozoa, and names it *Hæmogregarina* (*Testudinis*) *Stepanowi*.

Protozoa as food of Sardines.‡—MM. G. Pouchet and J. de Guerne found an extraordinary abundance of Peridinians in the viscera of sardines from La Corogne; the species represented were *Peridinium divergens* and *P. polyedricum*. The latter literally fills the digestive tube, being recognizable even in the rectum; they measure on the average 36 μ in diameter; bringing *P. polyedricum* to the spherical form this gives the volume of an individual as about 25 mm. Estimating the capacity of the intestine at 1 cubic centimetre it equals the volume of forty millions of Peridinians; allowing for the intestines, this number may be reduced one-half, but twenty millions must be regarded as a minimum, for the Peridinians break up rapidly in the intestine of the fish.

New Infusoria from New Zealand.§—Mr. T. W. Kirk describes as new *Opercularia parallela*, which differs from *O. cylindrica* in being more cylindrical, and having no striæ. *Acineta simplex* n. sp. has a wineglass-shaped lorica, the anterior half of which is occupied by the animal; the tentacles are capitate, and are arranged in two groups of about ten each. Eleven species of *Vorticella* are identified with species described by Mr. Saville Kent in his Manual, and though the antipodean specimens differ slightly, the differences do not seem to be of specific value. *Vorticella oblonga* and *V. zealandica* are new species.

'Challenger' Radiolaria. ‖—After ten years' work Prof. E. Häckel has published his gigantic report on the Radiolaria collected by H.M.S. 'Challenger,' by himself and by various friends; the thousands of new species which have been discovered opens up a new field for morphological investigation; the total number of forms described in this report amounts

* Arch. Slav. Biol., iii. (1887) pp. 33-49 (2 pls.). † Ibid., pp. 157-76.

‡ Comptes Rendus, civ. (1887) pp. 712-5. Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 323-4.

§ Ann. and Mag. Nat. Hist., xix. (1887) pp. 439-41.

‖ Reports of the Voyage of H.M.S. 'Challenger,' xl. (1887) 1803 pp., 140 pls.

to 4318 species, 3508 of which are new. For a really complete examination the lifetime of one man would not suffice.

The richest source of material was the Radiolarian ooze of the Pacific Ocean; the alimentary canal of aquatic animals, and the coprolites of the Jurassic period were full of specimens.

It will be useful to quote Prof. Häckel's definition of the Radiolaria:— "They are marine Rhizopoda, whose unicellular body always consists of two main portions, separated by a membrane; an inner central capsule (with one or more nuclei), and an extracapsulum (the external calymma, which has no nucleus and the pseudopodia); the endoplasm of the former and the exoplasm of the latter are connected by openings in the capsule membrane. The central capsule is partly the general central organ of the Radiolarian cell, partly the special organ of reproduction, since its intracapsular protoplasm, along with the nuclei imbedded in it, serves for the formation of flagellate spores. The extracapsulum is partly the general organ for intercourse with the outer world, partly the special organ of protection (calymma) and nutrition (sarcomatrix). The skeleton varies in form and is generally composed of silica, sometimes of acanthin. The cell usually leads an isolated existence (Monocyttaria), and only a small minority of one legion are united in colonies (Polycyttaria)."

The systematic catalogue is brought up to the year 1884, and contains 20 orders, 85 families, 739 genera, and 4318 species; this last is probably not one-half the number of recent species; two sub-classes may be established, the first, that of the Porulosa or Holotrypasta, containing the forms in which the central capsule is originally spherical, without osculum or principal opening with innumerable fine pores; the Osculosa or Mesotrypasta have the central capsule originally monaxid, with an osculum at the basal pole of the vertical main axis; each sub-class consists of two legions, first of the Spumellaria (Peripylea) and Acantharia (Actipylea), the second of the Nassellaria (Monopylea) and Phœodaria (Cannopylea). It is among the Spumellaria only that colonies are formed.

The characteristic capsule-membrane is not to be compared with an ordinary cell-membrane, but must be regarded as an internal differentiated product; the central capsule is regarded as the general central organ of the "cell-soul" for the discharge of its sensory and motor functions (comparable to a ganglion cell), and is also the special organ of reproduction (sporangium); it and the extracapsulum are to be regarded both morphologically and physiologically as the two characteristic co-ordinated principal parts of the unicellular Radiolarian organism. Sixteen geometrical types are recognized, and examples are given of each; the central capsule itself may belong to one of five well-marked different forms; the nuclei may be ellipsoidal, discoidal, stellate, amœboid or lobate. After describing the various secondary products which are also found within the capsule, the author passes to the extracapsulum which consists of the calymma or extracapsular jelly-veil, the sarcomatrix or layer of exoplasm immediately surrounding the membrane of the central capsule, the sarcodictyum or network of exoplasm, covering the surface of the calymma, and the pseudopodia or radial fibres of exoplasm, which are discussed separately and in detail.

In the fourth chapter the skeleton is elaborately dealt with; it is a part of the organism which is extremely well developed; in this chapter only the more important points are treated, the special differences being dealt with in the systematic portion of the monograph. In the ontogenetic development of the Radiolaria an *Astasia*-stage is succeeded by an *Actinophrys*-stage, that by *Sphærastrum*, and that by the *Actissa*-stage, *Actissa* being the prototype of the whole class.

The systematic disposition of this group is next considered, and is followed by the systematic description of its divisions, the whole work with its atlas of beautiful plates forming one of the most remarkable additions to zoological literature.

Psorosperms.*—Sig. A. Garbini finds that the granulations of the protoplasm and of the nucleus of Psorosperms found in the cæcum of the porpoise are not homogeneous, since by means of his double stain, some colour blue, others red. This difference only exists in the unincapsuled condition; at other times the granulations stain of one colour either all blue or all red. The author offers two explanations, either that before incapsulation the Psorosperm divides in such a way that all the blue-selecting granulations form one-half, and all the red-selecting the other half, or that during incapsulation the one set of granulations alter so as to become homogeneous with that of the other; in some cases becoming blue-selecting, in others red-selecting.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.†

(1) Cell-structure and Protoplasm.

Young Condition of Vacuoles.‡—Contrary to the generally accepted view, Herr F. A. F. C. Went has determined the presence of minute vacuoles even in the youngest cells, as, for instance, in the growing point. This was demonstrated by the application of a 10 per cent. solution of potassium nitrate, which kills the outer protoplasm and isolates the vesicles of cell-sap; they can then be burst by washing with water or by heat, and their fluid contents shown. The author found vacuoles also in oospheres, pollen-grains, and cambium-cells, and believes that they are present in all living cells, except possibly antherozoids, bacteria, and Cyanophyceæ.

Movements and changes take place at a very early period in these vacuoles, and the author believes that they always commence in the very youngest condition of cells, though they do not become readily obvious till a later period; these movements being always accompanied by changes in the form of the vacuole. Two frequently coalesce into a single vacuole, while others divide repeatedly by constriction through their middle. These processes are well seen in *Dematium pullulans*, in apical cells, meristem-cells, pollen-grains, and especially in young hairs; in young hairs of *Cucurbita Pepo* and in *Cladosporium herbarum* this division of a vacuole was seen to be followed by cell-division. All the vacuoles in a plant result, according to these observations, from the vacuoles of the oosphere, and these again from those of the mother-plant. Statements by previous observers of the fresh formation of vacuoles under certain circumstances he believes to be due to erroneous observation.

The author also calls attention to the occurrence in the same cell of vacuoles with different contents. In coloured cells it is not unfrequent to

* Acc. Agr. Art. Comm. Verona, lxiii. (1886).

† This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ Arch. Néerland., xxi. (1887) pp. 283–315 (2 pls.).

find a large vacuole with coloured contents and a number of small ones with uncoloured cell-sap. This is the case, for example, in the petals of *Camellia japonica*. From this fact a conclusion is drawn favourable to the view that the wall of the vacuole takes an active part in the storing up of the substances dissolved in the cell-sap.

(2) Other Cell-contents.

Acidity of the Cell-sap.*—Dr. Lange has investigated the nature and proportion of the acid constituents of the cell-sap in a number of plants, both succulent and thin-leaved. He supports Warburg's statement † that the less refrangible rays of the spectrum are more efficacious in decomposing acids than the violet portion. Although dead plants contain a smaller proportion of acids than living plants, this is not, he states, due to the presence of carbonic acid in the living plant. The author confirms the observation of Kraus, of a periodical increase in the acidity of the sap in the morning and a corresponding decrease in the evening. As a general rule, chemical changes in the plant proceed much more energetically in the luminous or red than in the chemical or blue half of the spectrum. Tables are appended of the amount of acid found in the cell-sap of a number of plants at different periods of the day.

Chemistry of Chlorophyll.‡—Mr. E. Schunk, considering the intimate connection between chlorophyll and the carbon dioxide of the atmosphere, thought it might be interesting to ascertain whether compounds of phyllocyanin could be obtained in which the organic or other acid could be replaced by carbonic acid. On passing a current of carbonic acid for several hours through an alcoholic solution of phyllocyanin holding hydrated zinc oxide in suspension, and by further agencies, a compound is obtained which is a phyllocyanin zinc carbonate; this is decomposed by the action of strong acids, and yields phyllocyanin and carbonic acid. The author gives an account of the action of caustic alkali and zinc, and of hydrochloric acid and metallic tin on phyllocyanin.

Researches on Chlorophyll.§—Herr A. Tschirch gives a *résumé* of the most recent observations on the composition of chlorophyll, and confirms his previous view that iron is not a necessary constituent of the green colouring matter of leaves.

For phyllocyanic acid (Schunck's phyllocyanin) he gives the formula $C_{28}H_{47}N_3O_6$.

As regards the proportion in leaves of the substance to which the absorption of CO_2 is due, he finds in *Fuchsia ovata* that it constitutes from 2·55 to 4·71 per cent. of the dried substance freed from ash, and from 0·6081 to 1·0 g. per sq. m. of the surface of the leaf. In *Begonia manicata* the figures were 1·8 per cent. and 0·3808 g. per sq. m.; in *Plectogyne* sp. 1·92 per cent. and 1·2328 g. per sq. m.

Researches on Green and Yellow Chlorophyll.‖—Dr. A. Hansen states that the orange-red pigment stated by several observers to have been found in leaves along with the yellow and red, is simply aggregations of the yellow chlorophyll-pigment, which has an orange tint when present in dense masses. He even obtained orange-red crystals.

* Ber. Naturf. Gesell. Halle, 1886, pp. 4–29. † See this Journal, 1886, p. 478.
‡ Proc. Roy. Soc. Lond., xlii. (1887) pp. 184–8 (1 pl.).
§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 128–35. Cf. this Journal, 1886, p. 88.
‖ Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 430–2.

Raphides in Typha.*—Dr. M. Kronfeld finds crystals of calcium oxalate in several species of *Typha*. They were found only in the male flowers, in the filament and connective, and especially in the endothecium or inner layer of the wall of the anther. In the female flowers they appear to be replaced by a yellow oily substance.

Calcium oxalate in the Cell-wall of Nyctagineæ.†—Herr A. Heimerl finds the presence or absence of a deposit of calcium oxalate in the cell-wall in different genera of this order to go along with other characters of taxonomic value. It occurs in the form of minute granules of irregular form, chiefly in the outer and inner walls of the epidermal cells of the stem and of both surfaces of the leaf, less often in the lateral walls of the same cells.

Presence of a Glucoside in the alcoholic extract of certain plants.‡—M. É. de Wildeman has found in the alcoholic extract of certain plants a substance which will reduce Fehling's solution. The reaction was well marked with an extract obtained from the leaves of the ivy; also with one obtained from the common *Pelargonium*. In the latter case tannin was also present, which was precipitated as a blue-black sediment by salts of iron. The author also prepared alcoholic extracts of certain algæ:—*Ulothrix zonata*, *Ulva Lactuca*, and *Nostoc commune*. In each case Fehling's solution was reduced. The glucoside present in each of the above has not yet been isolated.

Localization and Significance of Alkaloids in Plants.§—MM. L. Errera, Ch. Maistriau, and G. Clautriau state that in the majority of cases the alkaloids are found in the interior of the cells, dissolved sometimes in the cell-sap, occasionally in mucilaginous matter.

Alkaloids are distinctly local in their occurrence in the plant. They occur in active tissues such as the growing point or the embryo, or around the fibro-vascular bundles, or in the epidermis, or finally they may occur, as in *Papaver*, in the laticiferous vessels.

Physiologically, they may be considered as the waste products of the activity of the protoplasm.

Alkaloids are formed essentially in the active tissues, where they are decomposed and transformed into albuminoids. From the interior the alkaloids are transported towards the periphery in order that they may be more easily oxidized and to serve as a protection to the plant. When special secretions occur they are used as reservoirs to store the alkaloids.

(3) Secretions.

Caoutchouc in Plants.‖—Dr. Kassner has determined the amount of caoutchouc in the latex of several native (German) plants. In *Souchus oleraceus*, the mean of several experiments gave a percentage of 0·18 per cent. This was accompanied by an unusual proportion of proteinaceous substances (15·62 per cent.) and of potash (52·17 per cent. of the ash). In *Lactuca virosa* he found the proportion of caoutchouc in the fresh latex to be as high as 5 per cent. In *Chelidonium majus* and *Euphorbia Lathyris* only slight traces of caoutchouc were found in the latex. The latex of *Asclepias Cornuti* was also found to contain a considerable quantity of the same substance, but was not examined at the time of the year when the amount was likely to be the largest.

* Bot. Centralbl., xxx. (1887) pp. 154–6.
† SB. K. Akad. Wiss. Wien, xciii. (1886) pp. 231–46 (1 pl.).
‡ CR. Soc. R. Bot. Belgique, 1887, p. 34.
§ Errera, L., Maistriau, Ch., and Clautriau, G., 'Prem. Rech. sur la localisation et la signification des alcaloides dans les plantes.' Bruxelles, 1887, 29 pp. and 1 pl.
‖ JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) pp. 128–32, 181–6.

(4) Structure of Tissues.

Concentric Vascular Bundles.*—Herr M. Moebius classifies the cases where the fibrovascular bundles have a central phloëm and a peripheral xylem under five groups, viz.:—(1) The rhizome of Monocotyledons; (2) Monocotyledons with secondary growth in thickness; (3) Dicotyledons in which vascular bundles are formed—usually only at a later period—in the interior of fleshy stems and roots; (4) Bundles in the pith of dicotyledonous stems (this is by far the most numerous group); and (5) Cases difficult to group elsewhere; such as the bundles in the pith of the axis of the inflorescence of *Ricinus* (in these the concentric arrangement is often most strongly displayed). A systematic review follows of the families in which bundles of this kind occur.

Structure of Stomata.†—Dr. G. Haberlandt, referring to Schwendener's description of the structure of stomata,‡ points out that in addition to the outer "hinge," there is often, in addition, an "inner hinge," which may be simply a narrow strip of cell-wall, or may consist of the whole inner wall of the adjacent cells which has remained thin; a very good example of this structure is furnished by the stomata in the stem of the flax-plant.

The structure is described in detail of the stomata in the leaves of a large number of floating plants. The author asserts that the usual statement that these stomata have no power of opening or closing is not correct; the power is, however, much more feeble, and is lost at an earlier period, than is the case with land-plants. It is not dependent also, as in most stomata, on the contact of the bulging ventral walls of the guard-cells, but entirely on the more or less complete approximation of the greatly widened outer cuticular bands. The differentiation of the entire stoma into anterior chamber, central fissure, and posterior chamber, is nearly or entirely lost. The purpose of this structure appears to be to prevent the capillary stoppage of the fissure with water.

Clothing of Intercellular Spaces.§—M. C. van Wisselingh has examined, by the use of staining reagents, the nature of the layer which so often clothes the wall of intercellular spaces. In most cases he finds it to consist of the lignified outermost layer of the cell-wall, often easily separable and sometimes puckered into folds by the unequal growth of the subjacent layer. In the angle where two cells meet it is often raised up so as to form secondary intercellular spaces. A lignified outer layer of the wall adjoining intercellular spaces was determined by the use of reagents in the bark of *Sambucus nigra*, *Ligustrum vulgare*, and *Aucuba japonica*, in the cortex of the rhizome of *Convallaria majalis*, and of the root of *Menyanthes trifoliata*, and in the parenchymatous cells of the mid-rib of the leaf of *Aucuba*.

In other cases, especially in the neighbourhood of the stomata, this layer consists of a suberized or cuticularized substance, as in the large intercellular spaces in the leaf-stalks of *Nymphæa odorata*, and in many leaves. An apparently protoplasmic layer in the intercellular spaces was seen only in the root of *Lycopus europæus*.

Van Wisselingh's observations agree, therefore, rather with those of Schenk than of Russow. He confirms Gardiner's observation that in *Ligustrum vulgare* the clothing of the intercellular spaces consists of a lignified lamella of the cell-wall.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 2-24 (2 pls.).
† Flora, lxx. (1887) pp. 97-110 (1 pl.). ‡ See this Journal, 1882, p. 216.
§ Arch. Néerland., xxi. (1887) 15 pp. and 1 pl. Cf. this Journal, 1886, p. 471.

Relation of Secretory Channels to Laticiferous Vessels.*—M. A. Trécul states that as the contents of secretory channels and laticiferous vessels are analogous in physical and physiological properties, he proposes to employ the name laticiferous vessels for both sets of organs. Secretory channels may occur in the root, stem, or leaves. In *Argemone*, *Podostemon*, *Lactuca*, &c., they may be seen forming a network near the surface of the root, while in *Angelica sylvestris*, *Opoponax Chironium*, &c., the channels form a system extending through the whole plant.

The author calls attention to the simultaneous existence in the Compositæ of secretory channels and laticiferous vessels. In the Cichoriaceæ laticiferous vessels with a membranous envelope exist, while in the Senecionideæ and Asteroideæ the oleo-resinous channels have no envelope. In laticiferous vessels the latex is generally in a state of emulsion; rarely the juice is limpid. In the secretory channels, on the contrary, the emulsified condition is rarely found.

The latex of certain plants is decidedly nutritive, and in 1862 the author gave examples of certain Umbelliferæ, where the oleo-resinous juice produces true cellules in the interior of the channels. This may also be seen in the branches of *Brucea ferruginea*.

Laticiferous vessels of Calophyllum.†—M. A. Trécul states that in 1865 he described the structure of the leaves of *Calophyllum Calaba*, and pointed out the relation of the channels containing white milky latex to the fibro-vascular system. On the edge of the leaf, in the group of thickened cells forming the edge, there is a channel full of latex running at the side of the marginal vein.

M. J. Vesque has confirmed the observations published by the author in 1865. Spiral vessels were observed attached to the surface of the secretory or laticiferous channels interposed to the secondary veins, in the middle of the parenchyma which separates these parallel veins. These tracheids extend along the side of the channels in the form of bundles, and in transverse section are arc-shaped, and in from one to four layers.

These secretory channels are then surrounded in a great measure by the tracheids; but this is not all, as the tracheids, which are intimately connected with the surface of the secretory channels, communicate with the secondary veins, by bundles composed of narrow tracheids, and some fibres, in the same manner as those which are in contact with the secretory channels. The reservoirs of water are only the spiral cells themselves.

The author concludes that it is the latex which furnishes nutritive elements to the transverse bundles, and to those communicating with the secondary veins.

Anatomical peculiarities of Echites peltata.‡—M. L. de Saldanha has made a study of the stem and leaves of *Echites peltata* Vell. The stem is only a few millimetres in thickness, and contains an extremely astringent juice; its richness in tannin is remarkable. A transverse section of the stem shows the disproportion that exists between the diameter of tracheids, and of certain vessels that are found exterior to the woody cylinder. The diameter of the tracheids is extremely small, while that of the vessels in the periphery is large. The stem also contains laticiferous vessels, the latex being of a yellowish or golden-yellow colour.

Meristem of the Medullary rays of Cytisus Laburnum.§—From an examination of the medullary rays of the laburnum, showing that some of

* Comptes Rendus, civ. (1887) pp. 1034–9. † Ibid., pp. 27–32.
‡ CR. Soc. R. Bot. Belg., 1887, pp. 62–3.
§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 144–50 (1 pl.).

the cells of the layer from which they are produced become punctated with thick cell-walls like certain cells of the cortex, while large quantities of starch are formed in their interior, Dr. G. Haberlandt comes to the conclusion that the initial cells of the medullary rays acquire during the winter new functions connected with the transport of sap, and resembling those of the cortex.

(5) Structure of Organs.

Adventitious Roots.*—Sig. N. Terracciano found in a hollow in the trunk of a *Cupressus sempervirens*, two sets of adventitious roots, one above and one below, both variously ramified and independent of one another. After citing other similar cases, the author explains the adventitious production and the ascending course of the roots, by supposing that the lower roots which originated from the cambium layer of the trunk becoming inserted in the hollow, and the upper roots from the cambium layer of the branch descending into the cavity, and that they took their ascending course from compulsion, assisted by the damp mould in the cavity.

Tubercles on the Roots of Leguminosæ.†—From a very exhaustive examination of these structures, Herr A. Tschirch states that he has never found them wanting in any species of Leguminosæ examined, whether annual or perennial; they occur only on the underground organs, and always on the roots, never on underground stems. They are of two kinds, the lupin type and the robinia type.

The first type belongs almost exclusively to the genus *Lupinus*, and is found especially at the crown of the root. The tubercles are here swellings of the central vascular bundle of the root itself, having the appearance of an ordinary hypertrophy, and extending afterwards to other portions of the tissue, and forming a tuberous swelling. In the second and more generally distributed type, the origin of the swelling is always lateral; its mature form varies greatly. The two types vary also widely in their mode of development. In *Lupinus*, the centre of the swelling is occupied by a semicircular or roundish mass of tissue, which Tschirch calls the *bacteroid tissue* (the bacteria of Woronin, bacteroids of Brunchorst), almost always capable of growth. The entire tubercle is surrounded by an envelope of cork; root-hairs are always wanting. Starch is found in this tissue, especially in its early stages. By the time that the seeds are ripe, this tissue has become entirely emptied of its contents, and the tubercle dies away. In *Robinia*, *Phaseolus*, &c., on the contrary, the bacteroid tissue occurs at the apex of the tubercle, and continues to grow as its lower part becomes emptied of its contents.

The author agrees with Brunchorst that the so-called "bacteroids" are not living parasitic organisms, but organized albuminoid structures; the chief arguments for this view being their variable form, the invariable failure of all attempts at culture, and their behaviour towards staining reagents. They appear to approach most nearly in their properties to the group of caseins; and the tubercle must be regarded as a transitory storehouse of albuminoid reserve-material, to be used as wanted by the plant, especially in the maturing of the seeds.

With regard to the filiform structures which commonly (but not invariably) accompany the bacteroid tissue, and which have been regarded by previous observers as the hyphæ of parasitic fungi, or as plasmodial

* Rend. R. Accad. Sci. Fis. e Mat. Napoli, 1886, 1 pl.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 58–98 (1 pl.). Cf. this Journal, 1886, p. 271.

structures (by Frank as the originators of the bacteria themselves), the author is inclined altogether to doubt their fungal character, and to regard them as of the same nature as the bacteroid tissue itself.

The explanation given by Tschirch of the universal occurrence of these structures in the Leguminosæ, is the unusually large proportion of nitrogen required by this class of plants; they are therefore especially well developed when leguminous plants are grown in a soil containing but a small quantity of humus or nitrogenous constituents. They attain their maximum of development when the plant is in flower, gradually giving up their nitrogenous contents as the seeds ripen. They are not organs of absorption, and, as a general rule, the conversion of nitrates into albuminoids has taken place before the food-material reaches the tubercles.

Swellings on the Roots of the Alder and Elæagnaceæ.*—A fresh examination of these structures has led Herr B. Frank somewhat to modify his own previous view as to their nature, and to differ entirely from those who regard them as due to parasitic fungi. He finds the appearance of a carefully prepared section to differ in no respect from that of an ordinary spongy parenchyma full of protoplasm; and the so-called vesicles, to which such different interpretations have been given, to be nothing but accumulations of newly-formed albuminous substances in the rounded spaces of the originally porous protoplasmic structure.

These swellings are therefore identical in structure and function with the tubercles on the roots of the Leguminosæ as explained by Tschirch. They are organs for the temporary storing-up of albuminoids, to be again dispersed to those parts of the plant where they are required for the formation of new organs. The alleged parasitic fungi *Schinzia Alni* and *Leguminosarum*, *Plasmodiophora Alni*, and *Frankia subtilis*, must therefore be erased from mycology.

Shoots of Pyrola secunda.†—Prof. Kjellman describes the structure by means of which the so-called "wandering" of *Pyrola secunda* takes place. It depends on an annual increase and extension of the crown of the root, which promotes the exposure of the flowers and the consequent dispersion of the seeds.

Relationship between Stipule and Leaf.‡—Dr. M. Kronfeld gives further details of his experiments on the effect on a stipulate leaf of removing the stipules. It is only where these are large that the removal of either lamina or stipules appears to have a direct effect on the development of the other. In *Lathyrus Aphaca* and *affinis* the very large stipules appear to be the direct result of a reduction of the lamina to the condition of a tendril.

Comparative Anatomy of Tendrils.§—Herr G. Worgitzky describes the mechanical structure of tendrils in a large number of plants belonging to a variety of natural orders, and summarizes the results as follows:—

The arrangement of the tissues in tendrils or other organs performing the purpose of tendrils, is intimately connected with the requirements of their functions. The mechanical adaptation varies before and after the clinging to a support; this clinging is associated with more or less complete anatomical changes. The mechanical adaptation is also different in

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 50–8 (1 pl.). Cf. this Journal, 1886, p. 1033.

† SB. Naturv. Studentsällsk. Upsala, Oct. 26, 1886. See Bot. Centralbl., xxx. (1887) p. 94.

‡ Verhandl. Zool.-bot. Gesell. Wien, xxxvii. (1887) pp. 69–80. Cf. this Journal, *ante*, p. 271.

§ Flora, lxx. (1887) pp. 2–11, 17–25, 33–46, 49–56, 65–74, 86–96 (1 pl.).

the helicoid portions, and in those which are in close contact with the support; in the former case motility, in the latter case rigidity of the coils is the controlling factor, and the anatomical structure of the two regions therefore varies more or less. The two regions agree in the fact that their most important requirements are in connection with unilateral functions, and hence in the structure being dorsiventral. This dorsiventral structure is usually visibly indicated externally in both regions by a broadening on the concave side on a transverse section, commencing either with the origin of the organ, or more often at a later period.

Pitchers of Sarracenia.*—Herr P. Zipperer finds in *Sarracenia purpurea*, as in other species of the genus, that the pitcher secretes a fluid containing a diastatic and peptonic ferment, by which insects are killed, and the whole of their soft parts assimilated.

Formation of Hairs.†—Herr F. Krasan discusses the cause of the woolliness of the galls so commonly produced on several species of *Thymus* by the attacks of a *Phytoptus*. The hairs which cover these galls are in no way different from the normal trichomes of the plant, and especially from those which cause the woolliness of the variety *T. Chamædrys* var. *lanuginosa*, which frequently grows intermixed with individuals of the glabrous form attacked by the parasite, especially in very sunny situations, or where there are great and rapid alternations of heat and cold.

With these galls on *Thymus* may be compared the morbid structures known as phyllerium or erineum, tufts of hairs on the lamina of the leaf, very common on the vine, alder, lime, and on many herbaceous plants. Though these are generally believed to be caused by the attacks of mites, it is exceedingly difficult to detect the parasite in connection with them, and the disease is especially prevalent after injury by late frosts, followed by a period of intensely hot weather. The author believes that the formation of hairs does not result in these cases from the attacks of the parasite, but that both phenomena are due to the same cause, viz. special vital conditions, and especially the irritation caused by sudden and unusual changes in these conditions. The most prolific cause of irritation is an over-saturation of the organisms with ammoniacal substances and phosphorus salts, and consequent degeneration of the sap. This tendency is materially increased in the case of galls by the irritation resulting from the injury inflicted on the tissues by the parasite.

Normal Position of Zygomorphic Flowers.‡—Dr. F. Noll continues his researches on this subject, his latest observations being chiefly on the obliquely and transversely zygomorphic flowers of the Solanaceæ and Fumariaceæ, those of inverse origin of the Orchideæ, Lobeliaceæ, and Balsamineæ, and on leaves. The mathematical side of the subject is largely illustrated by formulæ. In addition to the ordinary and well-known changes in direction, the phenomena of torsion involve here, in many cases, a new kind of movement, exotropic lateral motion. It is this movement which causes the external position of the organ on its mother-axis, and hence its development in relation to the parent-plant. External forces do not play any direct part in bringing this about; the development is influenced by the mother-plant itself. The assumption of this exotropic motion, which can be experimentally confirmed, explains, in the simplest

* Zipperer, P., Beitr. z. Kenntniss d. Sarraceniaceen. Erlangen, 1886, 34 pp. and 1 pl. See Bot. Centralbl., xxix. (1887) p. 358.

† Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 7–12, 47–52, 93–7.

‡ Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 315–71 (8 figs.). Cf. this Journal, *ante*, p. 266.

way, the various movements in the course of development of the organ in question, even in their details. It is then seen how the normal position is attained in the shortest way; and that, in opposition to the theory of de Vries, the excess of weight on one side is, when necessary, counterbalanced by active tensions. The posterior torsion of flowers which become reversed and then again change their position, is a necessary result of this theory. The simplest case is that in which no torsion takes place during development, but where this is attained by median curvature; and to this all others may be traced. Special cases are treated in detail by the author.

Floral Conformation of Cypripedium.* — Dr. M. T. Masters first describes the general conformation of orchid flowers, and then that of *Cypripedium* in particular. The points specially worthy of notice are the lip, the andrœcium, and the gynæcium. The andrœcium is composed of one median stamen dilated into a broad shield-like staminode, and of two lateral fertile stamens within the preceding. Occasionally pleiomery of the stamens occurs. The author has observed triandrous flowers of *C. barbatum* and *C. Lawrenceanum;* tetrandrous flowers of *Uropedium* and *C. Lawrenceanum;* and hexandrous flowers of *C. Sedeni* ×. Increase in the number of stamens occurs more frequently in the inner staminal cycle than in the outer. Peloria in *Cypripedium*, as in other plants, is either (*a*) regular, or (*b*) irregular. The author has observed a case of regular peloria in *C. Sedeni* × ; the usual zygomorphic state being replaced by an actinomorphic condition. Cases of partial irregular peloria in *Cypripedium* are not uncommon.

The changes resulting from hybridization among the *Cypripedia* may be ranged under three categories:—(1) Those in which the changes occur in those characters which are more or less directly of an "adaptive" character. (2) Those in which there is in the offspring a more or less complete reversion to one or other immediate parent. (3) Those in which the change is decidedly teratological, and more or less affecting those "congenital" characters which constitute the symmetry of the flower.

Cupules of Cupuliferæ.†—Herr L. Celakovsky returns to the earlier view of Hofmeister, that the cupule of the true Cupuliferæ is of an axial character. He comes to this conclusion from a comparison of the lowest scales of the cupule of the beech, chestnut, and oak, with the bracts and stipules of the same plants, and from the structure of abnormal examples. The relationships are also discussed between the cupule of the true Cupuliferæ and the corresponding organ in the Corylaceæ.

Resistance of Pollen to External Influences.‡—Dr. P. Rittinghaus has made a series of experiments on the power of pollen-grains to resist extremes of external changes. Their subsequent capacity for germination was tested in a nutrient solution of sugar. He finds that most pollen-grains can resist a temperature of 90° C. for half an hour; the maximum temperature which was found not to destroy life was 104·5° for ten minutes. While low temperatures hinder germination, a lowering to −20° was found not to be fatal. A moderately high temperature (32°) promotes the growth of the pollen-tubes. The protoplasm of pollen is extremely sensitive to antiseptics, usually considerably more so than micro-organisms; poisonous gases have also a fatal influence. The duration of the power of germination of pollen-

* Journ. Linn. Soc. Lond., xxii. (1887) pp. 402–22 (1 pl. and 10 figs.).

† SB. K. Böhm. Gesell. Wiss., Nov. 12, 1886. See Bot. Centralbl., xxx. (1887) p. 10.

‡ Verhandl. Naturhist. Ver. Preuss. Rheinl., xliii. (1886) pp. 123–66.

grains varies between seventeen and sixty-six days, the average appearing to be from thirty to forty. Attempts to influence the direction of the growth of the pollen-tubes were without result.

Nectaries.*—Dr. S. Stadler describes the structure and development of the nectary in seventeen species of plants, with remarks on their mode of fertilization. *Melittis Melissophyllum*, *Cydonia japonica*, and *Œnothera Lamarkiana* have hispid nectaries. The methods of secretion are divided into four classes:—(1) Through uncuticularized tissue, as in *Agave;* (2) Through stomata, as in *Melittis;* (3) Through cuticularized tissue without upheaval, as in *Lilium;* and (4) with upheaval of the cuticle, as in *Diervilla.* *Asclepias Cornuti* has two kinds of nectary. The origin and course of the fibro-vascular bundles are described in the various cases, as well as the chemical reactions of the cell-contents of the nectariferous tissue.

Structure and Development of the Fruit of Anagyris fœtida.†—Sig. E. Martel examined separately the development of the epidermis, and then that of the fibrous zone of the pericarp. From the elements of the sub-epidermal parenchyma near the fibrous bundles is formed a second solid layer parallel to the fibrous stratum of the internal epiderm. The elements of these two zones are differently situated, a condition which contributes not a little to facilitate the dehiscence of the fruit. The author shows that in the pericarp of *Anagyris fœtida* there is no germinal zone, as stated by Cave for most fruits, and he concludes his work by refuting the opinions of Cave about the strata of the pericarp, and, although agreeing with Cave's views in general on stems, he declines to accept those relating to the origin of the layers which form them.

β. Physiology.‡

(1) Reproduction and Germination.

Entrance of Pollen-tubes into the conducting Tissue.§—Dr. P. Rittinghaus has studied the way in which pollen-tubes force their way into the conducting tissue of the style. An open canal in the style occurs especially in Monocotyledons. In other cases, of which *Chimonanthus fragrans*, *Camellia japonica*, *Lythrum virgatum*, and some others are given as examples, the surface of the stigma is not cuticularized, and the pollen-tubes find their way with great ease between the cells. But in the great majority of cases a certain degree of resistance is offered to the entrance of the pollen-tubes by the more or less perfect cuticularization of the surface of the stigma.

In these cases it is impossible to conceive that the extremity of the pollen-tube has any power of mechanically breaking through the cuticle; the entrance must be effected by means of solution or absorption. The substance which brings about this absorption is clearly to be found in the protoplasm of the pollen-tube, and is probably a peculiar enzyme. The passage through the cuticle is effected either on a papilla or at the base of one. The cuticle is absorbed by the substance contained in the pollen-tube, and an intimate fusion takes place between the pollen-tube and the papilla, so that the separation between them entirely disappears.

* Stadler, S., Beitr. z. Kenntniss d. Nectarieen u. Biologie d. Blüthen, 88 pp. and 8 pls., Berlin. See H. N. Ridley in Journal of Botany, xxv. (1887) p. 157.

† Ann. R. Istit. Bot. Roma, ii. (1886) pp. 51–7 (1 pl.).

‡ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

§ Verhandl. Naturhist. Ver. Preuss. Rheinl., xliii. (1886) pp. 105–22 (1 pl.).

The details of the process are described in the case of a number of plants belonging mostly to the Sileneæ and to the genera *Saxifraga*, *Cucurbita*, *Convolvulus*, and *Salix*.

Fertilization of Oxalis.*—Herr F. Hildebrand has made a series of experiments on the fertility of the different forms of the various trimorphic species of *Oxalis*. The following are among the more interesting results:—

Of *O. Lasiandra* the short-styled form is mostly known in cultivation. It propagates itself by bulbs for many generations, and produces the short-styled form only. It is incapable of self-fertilization, but abundance of capsules are produced when brought into contact with the mid-styled form. Of *O. tetraphylla*, *versicolor*, *brasiliensis*, and *compressa*, the long-styled forms are entirely sterile with their own pollen. Of *O. lasiopetala* the mid-styled form is altogether infertile by itself, but produced abundance of seeds in the neighbourhood of the mid-styled *O. articulata*, which germinated into hybrids. The mid-styled forms of *O. obtusa* and *Vespertilionis*, and the short-styled *O. cernua* and *Deppii*, were always sterile with their own forms, and the same is the case with both short-styled and mid-styled *O. bifida*, though this species was fertile if the two forms were intercrossed, and with the three forms of *O. hirta*.

In *O. Bowiei* the short-styled form exhibits a very imperfect fertility when pollinated from its own form, and the same is the case with the mid-styled *O. catherinensis*. Seedlings from this form of this species produced only mid-styled plants, while those resulting from the crossing of short-styled and mid-styled forms gave birth to these forms only, and no long-styled. Similar results were obtained with several other species. In *O. Valdiviana* and *speciosa* each of the three forms displayed a certain degree of fertility when pollinated from its own form, which was stronger in *O. lobata*, *pentaphylla*, and *crassipes*; and in the cases of the mid and long-styled *O. articulata*, the long-styled *O. incarnata*, *rosea*, and *Piottæ*, and the mid-styled *O. carnosa*, no self-sterility was exhibited.

Fertilization of Scandinavian Alpine Plants.†—Herr C. A. M. Lindman has examined the very rich flora of the Dovrefjeld in reference to the arrangements for fertilization. He finds a distinct tendency to a deeper colour in the flowers than is displayed by the same species in the lowlands, red and blue predominating. The great length of daylight appears to increase the size both of leaves and of flowers, though in some species, on the other hand, the flowers are diminutive in consequence of the low temperature. Crowded masses of small flowers are very common. The number of scented species is comparatively small, though the fragrance is sometimes powerful. The scarcity of insects necessitates that there should almost always be a provision for possible self-fertilization, and many species, elsewhere heterogamous, are here homogamous. Notwithstanding the cold and wet summer (1886), the plants observed almost invariably bore fruit.

Chemistry of Germination.‡—M. A. Jorissen regards the greater part of the nitrogenous substances formed in germination as derivatives of the albuminoids. The result of germination is not always a reducing process. The chief constituents of ash are phosphoric acid, potassa, magnesia, and lime. During germination a transport is effected of these substances from the cotyledons or endosperm to the embryo, this taking place at the expense

* Bot. Ztg., xlv. (1887) pp. 1–6, 17–23, 33–40.

† SB. Naturvetensk. Studentsällsk. Upsala, Nov. 11, 1886. See Bot. Centralbl., xxx. (1887) pp. 125 and 156.

‡ Jorissen, A., 'Les phénomènes chimiques de la germination,' 140 pp., Bruxelles, 1886. See Bot. Centralbl., xxx. (1887) p. 5.

especially of the phosphoric acid, potassa, and magnesia; the proportion of dissolved mineral substance is inverse to the advance of growth.

The author regards the transformation of starch into sugar as a purely chemical change, independent of any micro-organisms, for it is brought about by diastase even in the presence of the most powerful antiseptics. Seeds can therefore germinate without the assistance of these organisms. Ammonium salts are, he states, formed in germination.

Experiments were tried on the formation of solanine and solanidine in the potato, to determine whether they are produced in germination. He finds that they are not reserve-substances, but a diffusible form of nitrogen compounds. Amygdalin is also a plastic substance, and not a simple product of metastasis. It disappears only slowly on germination.

According to the author's observations, starch-grains may resist the unassisted action of diastase for months. In the rapid formation and transformation of the carbohydrates during germination he believes the albuminoids to play an important part, and that they are derivatives of a simpler substance, formic aldehyde.

Calcium is found universally in the cell-wall, and is probably essential to the formation of cellulose. The fatty-acids are formed at the expense of the albuminoids, independently of glycerin; on germination, fatty oils are split up into glycerin and a fatty acid. Sugar is not the invariable form assumed by carbohydrates during transport; it is not present in seedling hemp, nor in the epithelium of the scutellum of grasses.

Germination of the Date-palm.*—Although the date-palm comes under the denomination of "desert plants," Herr G. Firtsch finds the structure of young seedlings to present all the features of plants growing in wet situations, and requiring a large amount of moisture for their sustenance, such as the absence of root-hairs. The development of the seedling, and the structure of its various parts, are described in detail.

(2) Nutrition and Growth.

Apical Growth of Leaves.†—Herr P. Sontag has investigated the duration of the apical growth in leaves belonging to various divisions of the vegetable kingdom. In *Nephrolepis* and the Gleicheniaceæ the apical growth is unlimited, while in most Filicinæ it ceases after the formation of the lateral lobes. The same is the case in some Cycadeæ. In the leaves of Coniferæ apical growth ceases early, while intercalary growth may continue for several years. In Monocotyledons apical is very inconsiderable compared to intercalary growth.

In the leaves of Dicotyledons there are three types, viz.:—(1) Intercalary; apical growth ceases soon, when the leaf has attained a length of from 0·5–2 mm., the lateral portions being formed from a point below the apex. (2) Apical; all the lateral portions are formed in acropetal succession from the apex; this mode is specially characteristic of Umbelliferæ. (3) Mixed, some of the lateral parts being formed from the apex, others from an intercalary growing point; this is the case in all Compositæ.

Chlorophyllous Assimilation.‡—Prof. T. W. Engelmann replies to the objection against his statement that the maximum absorption of carbon dioxide by green leaves takes place in the red of the spectrum, founded on

* SB. K. Akad. Wiss. Wien, xciii. (1886) pp. 342–54 (1 pl.).

† Sontag, P., 'Ueb. Dauer d. Scheitelwachsthums u. Entwickelungsgesch. des Blattes,' 31 pp., Berlin, 1886. See Bot. Centralbl., xxx. (1887) p. 9.

‡ Bull. Soc. Belg. Micr., xiii. (1887) pp. 327–33.

the fact that Draper, Sachs, and others find a maximum assimilation in the yellow. He believes the apparent contradiction to arise from the circumstance that the observations of these experimenters have been made on leaves of considerable thickness, where the grains of chlorophyll lie one behind another. The thicker the absorbing layer of chlorophyll, the more —admitting the relationship between the absorption of light and its assimilating power—must the maximum of the disengagement of oxygen approach the maximum of energy in the spectrum, moving therefore from the region B–C in the red towards the region D in the yellow. If the incident light were completely absorbed by the leaf, the amount of disengagement of oxygen in each spot of the spectrum would be proportional to the luminous energy of that spot. If there is a smaller amount of available carbon dioxide than a grain of chlorophyll can decompose, it is evident that the whole of this carbon dioxide will be decomposed; and, under these conditions, as large an amount of oxygen will be given off in the yellow or green part of the spectrum as in the red; and the maximum assimilating power will be displaced towards the regions of less absorption, i. e. towards the yellow and green.

Action of the Ultra-violet Rays in the Formation of Flowers.*—Prof. J. Sachs gives details of the experiments from which he has come to the conclusion that the ultra-violet and invisible rays of the solar spectrum are especially efficacious in the development of flowers. The experiments were all made on *Tropæolum majus.* If the rays of the sun are made to pass through a solution of sulphate of quinine, the ultra-violet rays are entirely absorbed or transformed into rays of less refrangibility, and which are visible and of a light blue colour. If a plant is made to grow behind a screen of sulphate of quinine the vegetative organs are normally and luxuriantly developed, but the flowers are almost entirely suppressed. Twenty-six plants thus grown produced only a single feeble flower, while twenty plants grown under similar conditions behind a screen of water of the same thickness produced fifty-six flowers.

Prof. Sachs believes that extremely small quantities of one or more substances formed in the leaves cause the formative materials which are conveyed to the growing points to take the form of flowers. Acting like ferments, an extremely small quantity of these flower-forming principles may act upon large quantities of plastic substances. It may be assumed then that there are three distinct regions of the solar spectrum, differing in their physiological action—the yellow rays and those near them cause the decomposition of carbon dioxide, and are active in assimilation; the blue and the visible violet rays are the agents in movements of irritation; the ultra-violet rays are those which produce in the green leaves the substances out of which the flowers are developed.

Chlorophyll-function of Leaves.†—Herr A. Nagamatsz has determined by experiment the three following points, viz.:—(1) Leaves of land-plants, when completely submerged, do not assimilate; (2) after light has passed through one leaf, it has no power of inducing assimilation in a second leaf; (3) no starch is produced in withered leaves. The experiments were made on a number of different plants.

Absorption-bands.—Herr F. Stenger ‡ contests Reinke's conclusion that a maximum of absorption does not always correspond to a visible absorp-

* Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 372–88 (2 figs.).
† Ibid., pp. 389–407.
‡ Bot. Ztg., xlv. (1887) pp. 120–6. Cf. this Journal, 1886, p. 651.

tion-band in a spectrum. In solutions of chlorophyll in ether and of purpurin in alum he obtains different results from Reinke.

To this Reinke replies * that in the case of purpurin Stenger's results are vitiated by the use of a solution in alum instead of one in alcohol; and with regard to alcohol, repeating the experiments with a solution of the chlorophyll of *Elodea canadensis* in alcohol, and one of *Aspidistra elatior* in ether, he confirms his previous results that the chlorophyll-band III does not correspond in either case to a maximum of the absorption-curve.

(3) Movement.

Movements of Tendrils.†—Prof. D. P. Penhallow has investigated the mechanism of movement in *Cucurbita*, *Vitis*, and *Robinia*. He agrees with Gardiner and others in connecting the phenomenon of continuity of protoplasm with that of a distinct transmission of impulses to parts at a greater or less distance from the centre of irritation. This continuity appears most prominently in the collenchymatous tissue of the rather thick hypoderm; it may also be observed in the meristem of all parts external to the xylem-portions of the vascular bundles.

The results are, to a large extent, confirmatory of those already published. With regard to the average rate of movement; from a total of 436 distinct observations on *Cucurbita maxima* and *Pepo* under all conditions of temperature and humidity, the average rate of movement was found to be 0·316 cm. per minute. The maximum rate varies very widely; occurring in waves in the same tendril.

In the case of *Vitis cordifolia*, the main facts were found to be in general accordance with those of *Cucurbita*. Movements of circumnutation were found to arise through unequal growth of the tissues, represented chiefly by the vibrogen bands. The bands of more active growth are strictly localized. Movements due to irritation depend upon continued elongation of the opposite side, together with cessation of growth and contraction in the irritated parts.

In *Robinia pseudacacia* the leaves are characterized by a nyctitropic or true sleep movement. The soft tissue of the pulvinus is that in which the variations of tension under external influences is determined. The pulvinus of the whole leaf appears to determine the upward movement, while the included fibrous elements determine the downward and reflex movements. The various stages in the movements of the leaves and leaflets are described in detail.

Additional observations are also given on plants belonging to 22 species of 9 genera of Cucurbitaceæ, and the points described in which the tendrils differ from those of *Cucurbita*.

Rotation of Tendrils.‡—Herr J. Wortmann states that rotating movements sometimes take place in tendrils, in which the angles produced by the rotation change, thus resembling in all respects the movements of twining stems. As a rule the movements of tendrils are very much more irregular than those of twining stems; nor is the constancy of the same species always maintained as respects rotating to the right or to the left; occasionally the same tendril will coil in two opposite directions in different parts. With regard to geotropism, Herr Wortmann states that tendrils exhibit this property in the negative sense. Experiments which serve to demonstrate this are described in detail.

* Bot. Ztg., xlv. (1887) pp. 271–5.

† Trans. Roy. Soc. Canada, iv. (1886) pp. 49–83 (3 pls.), and Canadian Record of Sci., ii. (1886) pp. 241–50. Cf. this Journal, 1886, p. 652.

‡ Bot. Ztg., xlv. (1887) pp. 49–55, 65–72, 81–6, 97–100, 113–20, 138–41 (4 figs.).

Elasticity of Flexion in Vegetable Organs.*—Dr. E. Detlefsen describes an instrument and experiments by means of which he estimates what he terms the rigidity of the parts of plants, i. e. their power of resistance to forces which cause them to bend.

The apparatus consists of two perpendicular supports with knife-edges, on which rests the object the elasticity of which is to be tested. This is bent by weights suspended to a ring, attached by means of silk threads to a strong wire laid across the middle of the object. The changes of position of the object are observed in a mirror fixed to one end of the apparatus.

(4) Chemical Changes (including Respiration and Fermentation).

Intramolecular Respiration.†—Herr N. W. Diakonow has followed up his previous researches on the chemical conditions of cellular life by a series of experiments on cotyledons, seedlings, &c. His general conclusions are as follows:—(1) The intensity of the liberation of carbonic anhydride by vegetable cells in the absence of the oxygen of the air is determined by the processes of fermentation which take place within these cells; (2) the chemical action of free oxygen and the process of fermentation represent two chemical conditions which may replace one another in the metabolism of a vegetable cell: (3) without the chemical action of free oxygen, or without the aid of the process of fermentation, which is the only means of satisfying the requirements of a cell for oxygen in a medium in which this gas is not present, there is no liberation of carbonic anhydride, that is to say, no life.

Changes in the Proteids in the Seeds which accompany Germination.‡—Mr. J. R. Green corroborates v. Gorup-Besanez's conclusion that a proteolytic ferment exists in seeds during germination.

Seeds of *Lupinus hirsutus* were germinated for a week: they then gave an acid reaction. They were divested of their coats, the cotyledons were ground; the powder was extracted with glycerin and the extract dialysed till no trace of crystalline bodies formed during germination were to be found in the dialysate. The digestions were made in tubes of dialysing paper, so that the fluid outside enabled the author to see if peptone were formed or not. No trace of peptone passed the dialyser after a week's exposure.

The extract was acidified with 0·2 per cent. HCl, some boiled fibrin added, and left at a temperature of 40° C. The process of digestion was slow; but after a time a distinct biuret action was obtained. The course of digestion of the seed proteids was confirmed by examination of the seeds at different stages in natural germination. In addition to the biuret test the following test was also used:—The solution is freed from all other proteids by boiling with freshly prepared ferric acetate, and then treated with acetic acid and phosphotungstate of soda: peptone is thus precipitated.

The author summarizes his results thus:—

1. There exists in the seed of the lupin when germinating a proteolytic ferment which will convert fibrin into peptone, and then into leucin and tyrosin (thus extending v. Gorup-Besanez's result).

2. This exists in the resting seed in the form of a zymogen, which is easily converted into the ferment.

3. The ferment acts best in a slightly acid medium; its activity is

* Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 408–25 (4 figs.).
† Arch. Slav. Biol., iii. (1887) pp. 6–25.
‡ Proc. Roy. Soc. Lond., xli. (1886) pp. 466–9.

hindered by neutral salts and destroyed by alkalies; and it is most active at a temperature of 40° C.

4. The process of germination is started or accompanied by a transformation of the zymogen into ferment on the absorption of water and the development of vegetable acids in the cells of the seed.

5. The ferment so developed converts the proteids of the resting seed into acid albumin or parapeptone, peptone, and crystalline amides.

6. The nitrogen travels from the cells of the seed to the growing points in the form of the latter bodies, and not in that of peptone or other proteids.

γ. General.

Myrmecophilous Plants.*—In an exhaustive treatise on this subject Prof. F. Delpino distinguishes three different ways in which ants are attracted to plants, viz.:—(1) By honey-glands or extra-floral nectaries; (2) By the formation of special minute organs which serve to attract ants; (3) By the formation of receptacles in which the ants live. Of these, the first is by far the most common, the two latter occurring only in a few tropical plants. In the present publication, which is the first portion only of the treatise, the author enumerates a very large number of species provided with extra-floral nectaries, belonging to about thirty natural orders; of these the Leguminosæ include the greatest number. Delpino considers that ants and wasps play a most important function in the life of many plants, as the most active destroyers of their greatest enemies, such as caterpillars and the larvæ of other insects.

Effects of Low Temperatures on Plants.†—Prof. W. Detmer records several instances in which seeds can be exposed to very low temperatures (− 10° C.) without being killed, though, when they do germinate, the process is very much retarded. In some cases a temperature of − 17° C. is not sufficient altogether to kill tissues, and this is also the case with bacteria.

Goebel's 'Outlines of Classification and Special Morphology.'‡—This book is an expansion of Part II. of Sachs's 'Text-book of Botany,' but is in great part rewritten. The various groups of plants are taken up from the Thallophytes to the Phanerogams, and the main points of their morphology described. In Flowering Plants, the German classification of Angiosperms is still retained, which differs widely from that of Bentham and Hooker, universally adopted in this country. But Sachs's classification of Thallophytes, dependent entirely on the mode of reproduction, is abandoned, and they are divided into five primary groups:—Myxomycetes, Diatomaceæ, Schizophyta (Cyanophyceæ and Schizomycetes), Algæ (including Protococcaceæ and Characeæ), and Fungi. The work may be accepted as embodying the results of all the most recent observations on the structure of the various groups of plants.

B. CRYPTOGAMIA.

Development of Spermatozoids.§—Mr. Douglas H. Campbell describes the structure and development of the spermatozoids in several species belonging to the Filices, Rhizocarpeæ, and Muscineæ. His observations

* Mem. R. Accad. Sci. Bologna, vii (1886). See Bot. Centralbl., xxx. (1887) p. 38.

† SB. Gesell. Bot. Hamburg, April 22, 1886. See Bot. Centralbl., xxix. (1887) p. 379.

‡ Goebel, K., 'Outlines of Classification and Special Morphology of Plants.' Translated by H. P. F. Garnsey; revised by Prof. J. B. Balfour. 515 pp. and 407 figs. Oxford, 1887.

§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 120-7 (1 pl.).

agree in the main with those of Flemming with regard to the development of the spermatozoids in *Salamandra*. He regards the "head" of the spermatozoid of animals as strictly homologous to the "body" of that of plants.

Since the latest division of the mother-cells of all spermatozoids takes place nearly or quite simultaneously, the further development of the spermatozoids advances with uniform rapidity, so that all those in an antheridium are ripe at the same time. The walls of the mother-cells remain until the spermatozoids are nearly mature; then they are partially absorbed, and the separate cells become isolated, and at first still inclosed in a thin pellicle. Notwithstanding the small size of the nucleus, it is certain that it consists of an ordinary framework with relatively large microsomes.

The differentiation of the young spermatozoid begins with a contraction of the substance of the nucleus. On one side is found a more or less distinct fissure or constriction, so that the nucleus has a sickle-shaped appearance from above. The contracted framework of the nucleus has now the form of a thick curved band, the ends of which approximate, and the margins are bent inwards. As development proceeds this band becomes thinner and flatter, until it assumes its final form of a coiled thread. The change of form is accompanied by a corresponding internal differentiation. The reticulate structure gradually disappears, and the strongly refractive body of the spermatozoid becomes finally nearly homogeneous. If it is now stained with hæmatoxylin or saffranin, it is easily seen that the microsomes are still separated, while in the mature spermatozoid the whole of the band takes a uniform intense colouring.

The body of the spermatozoid is therefore formed out of the nucleus of the mother-cell. Their behaviour towards reagents shows that the cilia originate from its cytoplasm. They are formed only during the latest stage of development of the spermatozoid. The development of the vesicle, which is always present, advances *pari passu* with that of the spermatozoid. It results from the constriction which accompanies the first contraction of the nucleus, and increases in proportion as the nucleus contracts. The curved ends of the growing spermatozoid completely inclose it. It has an outer extremely thin wall, which is difficult to detect. It is clear that the vesicle is derived from the cytoplasm, which accounts for the presence in it of starch.

The fixing materials used in these observations were alcohol, a concentrated aqueous solution of corrosive sublimate, a 1 per cent. solution of chromic acid, and a concentrated aqueous solution of picric acid. The most convenient staining material, after fixing with alcohol or corrosive sublimate, is a very dilute aqueous solution of hæmatoxylin. Gold chloride often gave striking results after treatment with chromic or picric acid. Saffranin was also useful in some cases.

Cryptogamia Vascularia.

Prothallium and Germ-plants of Lycopodium inundatum.*—Further examination by Prof. K. Goebel of the prothallium of *Lycopodium inundatum* confirms previous observations. It agrees with the type of *L. cernuum* rather than with that of *L. annotinum* and *Phlegmaria*, growing erect, and containing chlorophyll in the portion above the surface. The cells are attacked by the hyphæ of a fungus, probably a *Pythium*, in the same way as the prothallium of *L. cernuum*. Antheridia and archegonia occur in close contiguity on the same prothallium. The young plant has a single

* Bot. Ztg., xlv. (1887) pp. 161–8, 177–90 (1 pl.). Cf. this Journal, 1886, p. 828.

cotyledon, and is distinguished from all other vascular cryptogams by the absence of a root, its place being supplied by a tuberous swelling, from which proceed a number of root-hairs; the cotyledon not unfrequently contains no vascular bundle. The stem-bud lies laterally beneath the cotyledon. A non-sexual mode of propagation was observed in the formation of adventitious shoots on leaves when detached from the young plant.

Anatomy of the Sporangia of Ferns.*—Continuing his previous researches on this subject,† Herr J. Schrodt contests the statement of Prantl ‡ that no air penetrates from the outside into the interior of the sporange, so as to cause its rupture. He states that the cells of the annulus of the ripe sporange contain water which evaporates through the thin membrane into the air. In this way the ends of the supports approach, the annulus is stretched, and the sporange ruptured at its thinnest spot. At the moment when the membrane which has become drawn into each cell of the annulus reaches its lowest point, and the surface of the inclosed water cannot sink any lower, a vacuum results, into which air is forced from without; and since this takes place at the same time in all the cells, the springing apart of the supports to which the spores are attached causes the latter to be violently thrown out.

Formation of Crystals in the Marattiaceæ.§—According to Herr N. A. Monteverde, the tabular crystals found in the parenchymatous cells of the Marattiaceæ do not consist, as previously supposed, of calcium and magnesium sulphate, but of calcium oxalate. Calcium sulphate does, however, occur dissolved in the cell-sap, and becomes separated in the form of sphærocrystals if the leaves of *Angiopteris longifolia* or *Marattia cicutæfolia* are laid for months in alcohol.

Apogamy in Ferns. ‖—Herr F. F. Stange describes the development of the apogamous prothallium in *Todea rivularis*, *T. pellucida*, and *Dodea caudata*, directly into the young plant. The anterior portion of the prothallium thickens into a solid mass of tissue, from the lobes of which the fronds are developed. He also describes the propagation of *Mohria thurifraga* by hibernating prothallia produced directly from tubercles somewhat resembling those of *Gymnogramme.*

Apospory in Polystichum angulare var. pulcherrimum Wills.¶—Mr. C. T. Druery has obtained specimens of *Polystichum angulare* var. *pulcherrimum*, in which, as soon as the fronds attained the length of 6 in. or so, the tips of the pinnules began to run out and dilate into prothalli, until the pinnæ were absolutely fringed with them. So far, the phenomena observed had been precisely similar to those noticed in Padley's form; but upon a closer examination, hydræform bodies attached to the upper surface of the pinnules, and within the margin, were noticed. These were in every case produced at the ends of excurrent veinlets protruding from the surface of the pinnules, and thickening at the distance of about 1/20 in. into a pear-shaped body, from which radiated in all directions numerous root-like hairs. Gradually this grew into an undoubted prothallus, though much thicker in substance than those produced by extension of the pinnule tips. From these observations it

* Flora, lxx. (1887) pp. 177–92, 202–8.

† See this Journal, 1886, p. 828. ‡ Ibid., 1886, p. 1020.

§ Arbeit. St. Petersburg. Naturf. Gesell., xvii. (1886) pp. 33–4. See Bot. Centralbl., xxix. (1887) p. 358.

‖ SB. Gesell. Bot. Hamburg, March 25, 1886. See Bot. Centralbl., xxix. (1887) p. 351.

¶ Journ. Linn. Soc. Lond., xxii. (1887) pp. 437–40 (3 figs.).

will be seen that the formation of a prothallus in this case is preceded by a very different series of phenomena from those previously recorded.

Structure of Davallia Mooreana.*—M. P. Lachmann states that the horizontal rhizome of this fern is composed essentially of two vascular bundles, which anastomose alternately right and left, and pass into two dorsal rows of leaves. The supporting tissue is composed of fusiform groups of fibres arranged irregularly round the conducting bundles; these fibres have their cavity filled with calcium oxalate, a peculiarity rare among vascular cryptogams.

Root of Hymenophyllaceæ.†—Contrary to the statement of Russow and Prantl, that there are always two vascular bundles in the root of *Hymenophyllum*, and either one or more than two in that of *Trichomanes*, M. P. Lachmann finds occasionally three bundles in the root of *H. demissum*, and always two in that of *T. spicatum*, *radicans*, and *spinosum*.

Rhizodendron.‡—Dr. K. G. Stenzel gives a minute description of *Rhizodendron Oppoliense*, a fossil tree-fern from the cretaceous marl near Oppeln. In close proximity to it are found also the remains of two other tree-ferns with which it might easily be confounded, *Protopteris fibrosa* and *P. Cottæana*, which are also described.

Muscineæ.

Protonema of Moss resembling Chroolepus.§—Dr. A. Hansgirg believes that many of the structures generally believed to be independent organisms, and described under the names *Trentepohlia*, *Chroolepus*, and *Gongrosira*, are in reality the protonemata of mosses. This is especially the case with *Chroolepus umbrinum*, *quercinum*, and *odoratum*, and *Trentepohlia uncinata* and *lagenifera*, and possibly also with *C. iolithus* and *rupestre*. He has repeatedly been able to trace the passage of the protonemata of mosses into protococcus- and palmella-forms. In moss-protonemata closely resembling *T. lagenifera*, he has been able to detect the development of zoösporangia corresponding, in position and size, to the normal zoosporangia of this alleged alga.

Glistening Apparatus of Schistostega osmundacea.‖—Dr. P. Vuillemin graphically describes the life-history and habit of the moss *Schistostega osmundacea*. In the deep damp fissures between stones the protonema generation flourishes, and the sexual phase becomes rare. The histological structure is briefly described. In specimens examined when fresh or after being fixed with osmic acid, it is seen that all the chloroleucites are accumulated in the protoplasmic mass at the posterior part of the cell, and there form a continuous pigmented layer, on which the anterior lens of hyaline matter concentrates the luminous radiations. As the incident radiation is diverted from the optimum, the chlorophyll-bodies become dispersed in the parietal protoplasm. The author describes the various arrangements of these bodies in response to the varying intensity of radiation. The glistening protonema can survive where the ordinary form would probably perish. Its propagation is effected by the stolon-like growth of the globular cells touching the soil, or by the formation of actual conidial spores from the highest cells

* Bull. Soc. Bot. Lyon, Avril 13, 1886. See Bull. Soc. Bot. France, ix. (1887), Rev. Bibl., p. 3.
† Ibid., Mai 11, 1886. See Bull. Soc. Bot. France, ix. (1887), Rev. Bibl., p. 3.
‡ JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) 30 pp. and 3 pls.
§ Flora, lxx. (1887) pp. 81–5.
‖ Journ. Anat. et Physiol., xxiii. (1887) pp. 18–30 (1 pl.).

of the refractive tufts. The details of this special mode of reproduction are described.

In considering the glistening property of the cells, the author reviews the incipient "eyes" of forms like *Peridinea*, and emphasizes the probability of the "eye" being primitively trophic rather than sensory. Besides the sensory function, the primitive "eye" is adapted to the absorption of solar energy. Nor is this primitive function wholly lost in higher grades of evolution.

Formation of Pores in Sphagnaceæ.*—According to Herr K. G. Limpricht, the presence of pores in the cortex of the stem of Sphagnaceæ is a more general phenomenon than is usually supposed, occurring universally, except in the *cuspidatum*-group. Besides the sharply defined pores, there are also frequently in the leaves larger irregular orifices in the cell-wells caused by resorption. Both kinds of orifice are connected with the more or less abundant formation of fibres.

Algæ.

Structure and Development of the Thallus in Florideæ.†—M. M. F. Debray describes the structure and development of the thallus in the genera *Chylocladia*, *Champia*, and *Lomentaria*. At the growing point are a number of apical cells having their apices in close contact, which divide repeatedly by transverse septa independently of one another, producing rows of cells. The divisions in the different rows correspond to one another so closely as to produce a uniform tissue. Each cell of these hyphæ divides immediately beneath the growing point by a longitudinal wall, the cortical cells being in this way separated. The cortical cells divide again by walls placed vertically to the surface but irregularly, a connected layer being thus formed which surrounds the whole of the branch.

The branching of the thallus is either dichotomous or lateral; and adventitious shoots may arise on older parts of the thallus when the cortex consists of only a single layer; or they are formed without any definite position from inner cortical cells.

Parasitic Alga of Emys europæa.‡—Dr. A. Peter discovered in the horny tissue of the carapace of *Emys europæa* a chlorophyllaceous alga, *Dermatophyton radians*, which forms fronds with a diameter of even 13 mm. The alga penetrates the horn and by its growth eventually forms a cup-shaped projection. It is a real parasite, as it derives its nourishment from its host.

Padina.§—Dr. F. Hauck proposes to classify the various forms belonging to this genus, hitherto considered as constituting one species only, under three groups, viz.:—

(1) Reproductive organs developed on both sides of every second filament-zone, forming, when ripe, double zones, separated from one another by a more or less conspicuous filament-zone. (Type: *P. pavonia.*)

(2) Reproductive organs developed on the upper side of every second filament-zone, forming, when ripe, intermediate bands between each second interstice formed by the filament-zones. (Type: *P. Commersoni.*)

* JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) p. 199. Cf. this Journal, 1886, p. 656.

† Bull. Scient. Départ. du Nord, ix., 14 pp. and 4 figs. See Bot. Centralbl., xxix. (1887) p. 354.

‡ SB. Gesell. f. Morphol. u Physiol. Münch., ii. (1887) pp. 117–8.

§ Hedwigia, xxvi. (1887) pp. 41–5.

(3) Reproductive organs developed on the upper side of each filament-zone, forming, when ripe, (often only rudimentary) intermediate bands between the successive interstices formed by the filament-zones. (Type: *P. variegata.*)

The comparatively rare oogonia and antheridia are arranged in the same way as the much more frequent tetrasporangia. Several new species are described belonging to each of the above groups.

Formation of Cysts in Ulothrix.*—M. E. de Wildeman records the formation of exogenous cysts in the sense in which the term is used by Gay,† in several species of *Ulothrix*. They appear to be formed under conditions of insufficient supply of moisture or nutriment, and constitute probably the only mode of propagation when the plant grows on the trunks of trees, on moist soil, or otherwise exposed to the air.

Allogonium.‡—Dr. A. Hansgirg claims priority for this generic name, including under it five species of Ulotrichaceæ, hitherto placed in different genera. He now sinks his own genus *Chroodactylon* as a section of *Allogonium*.

New Parasites of Daphniæ.§—M. R. Moniez has found a new species of *Amœbidium* (which he calls *A. cienkowskianum*) on several *Daphniæ* at Lille; a study of its characters has shown him that *Amœbidium* is a parasitic form of the free genus *Raphidium*, one of the Palmellaceæ; another new species is called *A. crassum*, and it is an endoparasite, having been taken from the intestine of *Eurycercus lamellatus*. The name of *Chytridhœma cladocerarum* has been given to a parasite of *Simocephalus retulus* and *Acroprus leucocephalus*; its zoospores are extraordinarily abundant in the blood, and are almost 3 μ at their greatest width; its contents vary considerably, and it appears to recall at one and the same time the Chytridiæ, Olpidieæ, and Ancylisteæ.

Another type of parasite, which must be placed with the Gymnoasceæ, is *Botellus*; *B. typicus* is a parasite of *Daphnia reticulata*, in the genital organs of which it is developed; *B. parvus* is found in *Cypris vidua*. The psorosperms or spores of fungi noted by various observers in the circulating apparatus of Daphnids have been investigated by the author, who groups them as (1) *Microsporidia obtusa* from *Simocephalus retulus* and *Daphnia reticulata*; *M. ovata* from *S. retulus* and *Chydorus sphæricus*; *M. elongata* from *S. retulus*; *M. acuta* and *M. incurvata* from *Daphnia pulex*.

Mountain Algæ.‖—Dr. A. Hansgirg compares the algal flora of the mountain-region of Bohemia with that of the lowlands and plains. A large number of the species comprising the latter occur also in the former region, chiefly cosmopolitan species; but there are also many peculiar to the higher altitudes, though the total number of species is smaller. The moist silurian limestone rocks in the neighbourhood of Prague have a peculiar algal flora, several very rare species, belonging especially to the Phycochromaceæ, being found in the clear springs and brooks in this region; and a different flora is again characteristic of the primary mountains of Bohemia. The floræ of the carboniferous, cretaceous, and tertiary formations of Bohemia are less rich and more uniform, but include some rare species of Phycochromaceæ. A list is given of some species belonging to all classes found only at great altitudes in the Riesengebirge.

* CR. Soc. R. Bot. Belg., 1887, pp. 52-5.
† See this Journal, *ante*, p. 277.
‡ Hedwigia, xxvi. (1887) pp. 21-3.
§ Comptes Rendus, civ. (1887) pp. 183-5.
‖ Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 13-17, 54-8, 97-101.

Endochrome of Diatoms.*—Sig. M. Lanzi records several instances of the occurrence of granular endochrome in placochromatic, and of undivided endochrome-discs in coccochromatic diatoms. In the former case the girdle-bands were always broad, from which the author concludes that propagation took place by division of the cell-contents. *Amphora ovalis* he has seen in various stages of development without previous conjugation or formation of resting-spores. *Nitzschia Palea* he has also been able to trace in its development from very minute gelatinous spores.

Raising Diatoms in the Laboratory.†—Prof. S. Lockwood gives various details of a series of experiments he has been making on raising diatoms in a laboratory. An experiment made in Dec. 1882, and since frequently confirmed, demonstrated that diatoms originate from spores. These spores are exceedingly minute, passing easily through filter-paper. They are probably immotile resting-spores, and may be held in suspension a while, like the mineral matters in turbid water. The viability of these spores is remarkable. The diatoms raised in one series of experiments were from spores whose life-force had lain dormant in total darkness for thirteen or fourteen years; and in another series sixteen years. The viability of some genera is greater than that of others. This is notable of *Navicula* in these experiments, and is consonant with the numerical lead of this genus in forms or so-called species.

Owing to the environment becoming abnormal, development may be rapid and erratic to a surprising degree, but upon aberrant and asymmetrical lines. Suppressed at some points, the life-energy is precociously active at others. Diatoms have embryonal stages or forms, with silicate fronds. As to kind and quantity, the crops are capricious and vary without apparent reasons. As to the parentage of the spores, they were not in these experiments generated in the vessel, but were derived from sporangial mother-cells.

The author performed in all twenty experiments; he found that the diatoms generated could be referred to three genera, i.e. *Nitzschia*, *Amphora*, and *Navicula*.

A table containing the measurements of each accompanies the paper: *Nitzschia* varies from 1/430–1/414 in. in length and 1/4000–1/6000 in. in thickness, *Amphora* from 1/1090–1/1500 in. in length and 1/2570–1/5000 in. in thickness, and *Navicula* from 1/1090–1/4000 in. in length and 1/4500–1/12,000 in. in thickness.

Fungi.

Latex-receptacles of Fungi.‡—Dr. G. Istvánffy and Dr. O. Johan-Olsen classify the latex-receptacles and similar structures of the higher fungi under three heads, viz. (1) Latex-receptacles proper; (2) oil-receptacles; (3) pigment-receptacles, or those which contain a substance which colours in the air.

The latex-receptacles proper or latex-tubes are of large diameter compared to the surrounding hyphæ, have a very soft extensible cell-wall, and exude, on being cut, a turbid finely granular fluid varying in colour according to the species. Their form does not vary greatly; they are seldom divided by transverse septa, but are usually much branched; they are connected with the contiguous tissue-hyphæ, and are often curved or

* Atti Accad. Pontif. Nuovi Lincei, xxxvii. (1886). See Bot. Centralbl., xxix. (1887) p. 321.

† Journ. N.Y. Micr. Soc., ii. (1886) pp. 153–65 (2 pls.).

‡ Bot. Centralbl., xxix. (1887) pp. 372–5, 385–90.

spirally coiled. In *Lactarius*, *Mycena*, and some Polyporeæ they contain a true latex; in other Polyporeæ and in *Fistulina* a fluid containing tannin; in some Agaricineæ again they contain a more or less clear sap. Their origin is usually the same, as lateral buddings from mycelial filaments. Their distribution varies greatly, and may be arranged under three types, viz.:—

(1) The *Lactarius*-type. In most species of this genus the greatest number of latex-tubes occur in the subhymenial layer, and in the periphery of the stipes; the former branches on the one hand into the hymenium, on the other hand into the tissue of the pileus. According as the cortex consists of one or more layers, these tubes are also in a single or a double layer. In the pileus they run either parallel or obliquely to the surface of the lamellæ.

(2) The *Mycena*-type is much more simple. The latex-tubes are extremely long, running through the periphery of the entire stipes, and ending in the central tissue of the pileus. There is no subhymenial layer of latex-tubes.

(3) The *Fistulina*-type. The latex-tubes are distributed through the entire receptacle, and are not collected in definite spots; comparatively few are found in the hymenium.

The latex-tubes pass by insensible gradations into the oil-receptacles, which differ from the former more in their contents than their form. The substance contained in them is usually dense and strongly refractive during the greater part of their period of growth; though in some species of *Stereum* and *Corticium* it is a turbid fluid. These tubes are always undivided and seldom branch; their walls are thin and soft; the parietal layer of protoplasm can be detected throughout their existence, and often contains several nuclei. Their form is either that of long tubes, short cells swollen into a club-form, or spherical cells. They are formed in the same way as the latex-tubes, often in the mycelium.

The pigment-receptacles show no sharp distinction from the oil-receptacles. They occur in many species of *Lactarius* and *Mycena*, where the substance is of a very similar nature, and often assumes a bright colour only on exposure to the air. In many poisonous species of *Boletus* they contain the poisonous principle dissolved in the cell-sap. These receptacles are usually slender much-branched tubes; they are most abundant in the periphery and basal parts of the stipes, but occur also in the pileus and hymenium.

Cystidia of Fungi.*—Dr. R. v. Wettstein regards these structures of the Hymenomycetes as having very different physiological values in the different genera. In *Coprinus* they are at first protective organs for the young spores in the course of their development. In the mature receptacle they serve partly the same purpose, or they fuse together, or force themseves into the neighbouring lamellæ, preventing the rupture of the pileus. The author considers them as but of little value for taxonomic purposes.

Infection through parasitic Sclerotia.†—Herr J. H. Wakker has closely investigated a disease which is very destructive to hyacinth-cultures in the neighbourhood of Haarlem. It makes its appearance after the time of flowering, causing the leaves to turn yellow and fall off. No mycelium can be detected in the parts above ground, except at the very base of the leaves. The roots have often died off altogether, and the bulb is com-

* Verhandl. Zool.-bot. Gesell. Wien, xxxvii. (1887) p. 6.

† Bot. Centralbl., xxix. (1887) pp. 309–13, 342–6. Cf. this Journal, 1883, p. 686.

pletely permeated by mycelium. On its surface are black irregular sclerotia, and others in a younger softer condition. When once attacked by the disease, the plant inevitably perishes. The peziza-form will develope from the sclerotia in the course of the next spring. This very closely resembles *P. Trifoliorum*; but inasmuch as the author found it impossible to infect clover with sclerotia from the hyacinth, or the reverse, he proposes for it the distinctive name *Peziza bulborum*. In addition to *Hyacinthus orientalis*, it occurs also in species of *Scilla*, and very rarely in *Crocus*.

Germ-filaments produced from the spores in water produce sporidia, and then perish, without infecting the host; and, although it is quite possible to produce an infective mycelium from spores, the ordinary mode of infection is by the sclerotia only, the peziza-cups being comparatively rare in nature. It is very easy to produce mycelium artificially from the sclerotia, by removing the cortex or placing them in a nutrient solution; in the former case a fresh cortex is rapidly formed. By means of secondary sclerotia, produced from the primary ones, the parasite is able to maintain itself throughout an entire year almost without nutriment; and these secondary sclerotia are the chief agents in the infection.

Fluorescence of Fungus Pigment.*—According to Dr. A. Weiss, the alcoholic extracts of fungi are all more or less fluorescent. The fluorescing cone appears either green (yellow or brown fungi) or blue (red or violet fungi); but the ochre-yellow pigment of some Agaricineæ fluoresced an intense azure, the red pigment of the pileus of *Amanita muscaria* green. The spectrum of the blue fluorescing pigment of *Russula* and other fungi showed a broad black absorption-band in the yellow-green, a thin one between E and F, a total absorption of the violet to G. The band in the yellow-green coincides with the band which the spectrum of a living red peony leaf shows there, and likewise with that of the blue pigment of many species of *Campanula* after treatment with sulphuric acid. The more intense the colour of the extract, the more the absorption extends towards the red; so that with very thick layers of fluid the whole green and yellow seem extinguished. The absorptions in the violet are similar to those of the red, blue, and violet pigments of flowering plants. The green fluorescing fungus-pigments show a faint absorption-band between E and F, and a broad absorption of the violet end of the spectrum.

Pathogenic Fungi.†—Mr. J. C. Arthur continues his reports to the New York Agricultural Experimental Station. That for 1885 is devoted chiefly to the study of plant diseases. The following topics are mentioned amongst others:—

Spotting of Quince Fruit.—This is due to a fungus, *Morthiera Mespili* Fckl. var. *Cydoniæ* C. & E., always present to some extent on the leaves of the quince. On the fruit it forms circular blackish spots with a red or white margin and a dot or two at the centre.

Rotting of Tomatoes.—The disease, or diseases, causing the rotting of green fruit, and the early decay of the ripe fruit of tomatoes, seems as difficult a problem to solve after another year's observation and experiment as ever. A fungus, *Macrosporum Solani* E. & M., appeared in great quantities this year; it is often accompanied by a simple-spored fungus, *Phyllosticta Solani* E. & M., which may indeed be but a later condition of it.

Lettuce Rust.—This disease, due to a fungus, *Septoria Lactucæ* Pass., has

* SB. K. Akad. Wiss. Wien, xci. (1885) pp. 446–7.

† Rep. of Botanist to N. York Agricultural Experimental Stat., Geneva, N.Y., for 1885, Albany, 1886.

been very prevalent during both 1884 and 1885. If a plant having this disease be examined closely, both surfaces of the leaf will be found to be covered with minute brown or blackish specks, as fine as pin points, their great abundance giving the rusty colour. The vegetative threads of the fungus are not visible, being concealed in the tissues of the lettuce. It is, therefore, an endophytic species.

Lettuce Mildew.—This fungus, *Peronospora gangliformis* dBy., first appeared in irregular patches half an inch or more across on both surfaces of lettuce leaves. The vegetative threads of the fungus grow within the leaf and only come to the surface to form spores.

Rotting of Cherries and Plums.—Von Thümen considers this fungus (*Oidium fructigenum* S. & K.) to be perhaps the most noxious and destructive of all kinds that occur upon fruit. The fungus consists of colourless, much branched and septated threads permeating the tissue of the fruit. The fruiting threads consist of short sections, each a little more swollen as they approach the ends of the threads where the sections are elliptical.

Disease of Clover-leaf Weevil.—In the latter part of May, great numbers of pale-green larvæ, nearly an inch long, were found clinging to the grass and clover of the meadows, apparently dying from the attack of some fungus. Dissecting a sick larva before death has occurred, a close network of fungoid threads will be found among the muscles which line the wall of the body. They are profusely branched, colourless, without septa, the contents finely granular, and with or without vacuoles, or clear spots, of variable size. This mycelium grows rapidly, and soon encroaches upon the body-cavity of the insect, encompasses the various organs, finally absorbing the juices and filling up the body with a solid mass of the fungus. The spores are formed at the end of each mycelial branch; some of the branches, however, are enlarged and sterile. The spores are oblong, rounded at both ends, one-celled, with thin walls and colourless granular contents, and are comparatively large. The fungus is *Entomophthora Phytonomi* Arth.

In his Report for 1886, Mr. Arthur* deals further with the question of plant diseases. The following is the order of topics:—

Rotting of Tomatoes.—Another year of observation on tomatoes strengthens the opinion that the rotting of the fruit is not brought about by a single agency, but by several, sometimes combined, but more usually acting independently. The objects of the note are to point out that the soft rot, chiefly affecting ripe fruit, must be discriminated from the brown or black rot affecting green fruit. Probably Dr. Halsted is correct in referring the decay in green fruit to *Cladosporium fulvum.*

Disease of Clover-leaf Weevil.—Further study of *Entomophthora Phytonomi* Arth. reveals the fact that when the spores are germinated upon the surface of water they take on a different development. Instead of at once producing mycelium, they send out a short slender pedicel from one side, which bears a solitary minute spore. The minuteness of these secondary spores, and their aërial formation, makes it evident that they serve for long distance transportation by wind.

Strawberry Mildew.—This fungus, *Sphærotheca Castagnei* Lev., produces a delicate white cobwebby growth, which overspreads the plant attacked. Later in the season, the resting or winter spores are formed in minute globular spore-cases, which are first yellow, then change to black as they ripen.

* Rep. of Botanist to N. York Agricultural Experimental Stat., Geneva, N.Y., for 1886, New York, 1887.

Plum-leaf Fungus.—This fungus, *Septoria cerasina* Pk., first becomes conspicuous to a careful observer about the middle of July. It starts at isolated points on the leaf-blades, apparently from spores derived from the air, and spreads into a circumscribed area, usually not exceeding one-eighth of an inch in diameter, and more commonly but half that size. The spots are usually more or less rounded, but may be angular when bounded by veins. The fungus produces three sets of spores at different seasons of the year; the septoria-spores in summer, the phoma-spores in winter, and the ascospores in spring. It is reasonable to suppose that the three sorts of spores have three diverse and important offices to perform. As to the ascospores, they germinate upon the leaves of the plum-tree in spring, and start the new growth that some time afterward bears the septoria-spores. The phoma or winter spores may be of sexual nature, and perform the office of the male element in originating the ascophorous stage of development.

New Genus of Ascomycetes.*—Herr H. Zukal describes the new genus *Baculospora* with the following characters:—No stroma; mycelium very transient, and feebly developed. Perithecia half imbedded, membranous, pellucidly yellow. Asci club-shaped, apiculate, with greatly thickened wall, and eight cylindrical brown ascospores. The only species, *B. pellucida*, was found on horse-dung.

Ancylisteæ and Chytridiaceæ.†—Pursuing his investigations on these groups of fungi, Herr W. Zopf finds that a convenient mode of culture is on pollen-grains in water. He was in this way able to follow out the life-histories of *Lagenidium pygmæum* and *Rhizophidium Pollinis-Pini*. The germinating tube of the swarmspore readily penetrates the membrane of the pollen-grain, and developes into a spherical, ovoid, or kidney-shaped bladder, which is transformed into a sporange, within which swarmspores are again formed. After some days the sexual organs are also produced. An undescribed species of *Rhizophidium* he finds parasitic on a diatom, *Cyclotella operculata*, which puts out its mycelial tube between the valve and the girdle-band, thus penetrating into the cell. Another new species, *R. sphærotheca*, attacks the microspores of *Isoetes lacustris*, producing in them a fatty degeneration.

Mycorhiza.—Herr B. Stein ‡ confirms the observations of Frank on the occurrence of a symbiotic fungus on the roots of trees, and enumerates a large number of species in which he finds its presence to be constant. He regards the fungus as playing a most important part in supplying nutriment to the trees on which it grows.

M. F. Kamiénski § believes that true symbiosis of a fungus-mycelium with a root is not so common a phenomenon as Frank supposes. In the case of *Carpinus Betulus* he finds that the fungus which clothes the roots has a distinctly prejudicial influence upon them, causing hypertrophy of the tissue, and in that of *Pinus sylvestris* abnormal dichotomous branching and resinosis in the vascular bundles of the roots. *Monotropa hypopitys*, on the contrary, furnishes an example of true mycorhiza, the fungus being found on the surface of the root, not as a parasite, exercising no injurious influence, and carrying nutriment to the root.

* Verhandl. Zool.-bot. Gesell. Wien, xxxvii. (1887) pp. 39–40 (1 pl.).

† Ber. Naturf. Gesell. Halle, 1886, pp. 31–7. Cf. this Journal, *ante*, p. 283.

‡ JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) pp. 409–12. Cf. this Journal, 1886, p. 113.

§ Arbeit. St. Petersburg Naturf. Gesell., xvii. (1886) pp. 34–6. See Bot. Centralbl., xxx. (1887) p. 2. Cf. this Journal., 1886, p. 113.

Green colour of decaying wood.*—Herr H. Zukal has carefully examined the green colouring matter of *Peziza Jungermanniæ* and *P. æruginosa*, both of which are frequently found on decaying wood. He finds the pigment of the two species to behave the same with various reagents, and that it can pass out of the mycelium into the adjacent wood. This is probably the cause of the green colour often seen in rotten wood.

Protophyta.

Chemical constituents of Bacteria.†—Herr L. Vincenzi gives details of experiments relating to *Bacillus subtilis*. A pure culture was obtained by Roberts's method. The fluid containing them was filtered through asbestos, the bacteria remaining on the filter were washed with water and 0·5 per cent. sodium hydroxide solution, digested with artificial gastric juice for twenty-four hours, washed free from peptones; finally, they were washed with alcohol and ether and dried. In the cell-wall, which was all that remained after this treatment, no cellulose was found; but it was nitrogenous, yielding from 5·3 to 11·15 per cent. of nitrogen in different specimens, the amount seeming to depend on the different stages of growth of the bacteria. No opinion is expressed as to the nature of this nitrogenous substance.

New Species of Spirillum.‡—Prof. N. Sorokin found in the hollow stem of an old and rotting poplar a whitish foul-smelling fluid. The white colour was found to be due to crowds of a very motile *Spirillum*. No other microbes were present, so that there was quite a pure cultivation. The contents of the *Spirillum* were transparent, granules in the protoplasm not being observed. Multiplication took place by simple division. Occasionally the micro-organisms were collected into not very large zooglœæ.

Among the forms which rapidly flitted across the field of vision, there were some which were either quite immobile, or at most turned from one side to the other. In these, spores could be perceived. Their diameter was less than that of the parent cell, and their number greater according as the organism was longer. The reproduction-organs germinated in the parent cell. The germs developed into rodlets, which in fifteen to twenty minutes began to twist and separate. The young *Spirillum* had usually two turns, the adult not more than three. The curvature might be more or less marked. As the young *Spirilla* did not always separate from the parent cell, large specimens were frequently seen still attached to the parent *Spirillum*, so that a branched form was produced. It is noteworthy that the spores, so long as they remain within the parent cell, possess no cell-wall, and present only a small collection of minute granules. From this characteristic development, the author has called this organism *Spirillum endoparagogicum*.

New Micro-organisms obtained from Air.§—Messrs. G. C. and P. F. Frankland have cultivated a number of organisms from the atmosphere, and have studied their distinctive characters; a list is given, among which are five *Micrococci*, ten *Bacilli*, and two *Saccharomyces*.

Distribution of Micro-organisms in the Air.‖—Since the last report on the subject by Dr. P. F. Frankland,¶ he and Mr. T. G. Hart have made

* Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 41–6.

† Zeit. Physiol. Chem., ii. pp. 181–3. See Journ. Chem. Soc. Lond., Abstr. 1887, p. 393.

‡ Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 465–6 (1 fig.).

§ Proc. Roy. Soc. Lond., xlii. (1887) pp. 150–1.

‖ Ibid., pp. 268–82.

¶ See this Journal, *ante*, p. 453.

further experiments with Hesse's tubes, both on the roof of the Science Schools and in the interior of buildings.

To obviate the melting of the tubes in hot weather they were wrapped in bibulous paper saturated with water, and this was surrounded by tissue paper.

In the open air the number of micro-organisms increases with the temperature; thus in January, with temperature of 3·5° C., only four colonies (average) per 10 litres of air were obtained, whilst in August, temperature 18·3°, as many as 105 colonies were found.

In the interior of buildings the same result as in the previous communication was arrived at, viz. that micro-organisms are more numerous when the air is disturbed than when no movement is going on.

A table of results and a table of curves formulating the results conclude the paper.

MICROSCOPY.

α. Instruments, Accessories, &c.*

(1) Stands.

Jaubert's Microscopes, Eye-pieces, Objectives, &c. — One of the most extraordinary patents on the file of the Patent Office † is certainly that of M. Leon Jaubert for "Improvements in Optical Instruments." Five large sheets, 27 by 19 inches, are filled with 189 figs., 125 of which illustrate his ideas of improvements in both Monocular and Binocular Microscopes and describe objectives and eye-pieces of special arrangement made of concentric layers of glass united in groups, multiple objectives, revolvers for eye-pieces and objectives, a rotary micrometer, prisms, and other similar matters. We have selected the following as sufficiently showing the patentee's views, and if more information is desired the specification of the patent is available in the Library.

Universal Microscope.—This is copiously illustrated in all its parts in the Specification, but we give in preference (fig. 155) a modern form of the Microscope, as actually constructed by the patentee and recently exhibited by him. It has an oval base S, supporting two pillars C, which are bent towards each other at the upper ends, so that the trunnion or inclining axis ϕ is much smaller than usual; a spring-catch f engages in a series of holes in the socket A of this axis to fix the various positions of inclination. A second axis is applied in front of A to provide lateral inclination of the stem B, carrying the arm B′, the body-tube T, the stage P, the mirror G, &c.; a spring-catch r fixes the position by means of a series of holes shown on the collar. The stem B has a rack on either side on which acts a screw-collar E, raising or lowering it in the socket A′. A similar mechanism is applied to the body-tube for the coarse-adjustment actuated by the screw-collar E^1 with a slow movement by the screw-collar E^3. A third screw-collar at E^2 focuses the micrometer in the eye-piece. The fine-adjustment has two rates of motion by the milled heads V and V^1. The substage H is provided with a fine-adjustment actuated by the screw-collar e^2.

We have not attempted to give the full description of the patentee, but

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† 1866, No. 473, 14th February. Cf. also Les Sciences. i. (1883) pp. 55–7 (3 figs.), and pp. 9, 11, 31, 46, 62–3, 78, and 109.

the general features of the construction are sufficiently obvious from the foregoing. The main speciality of the instrument consists in the two axes,

FIG. 155.

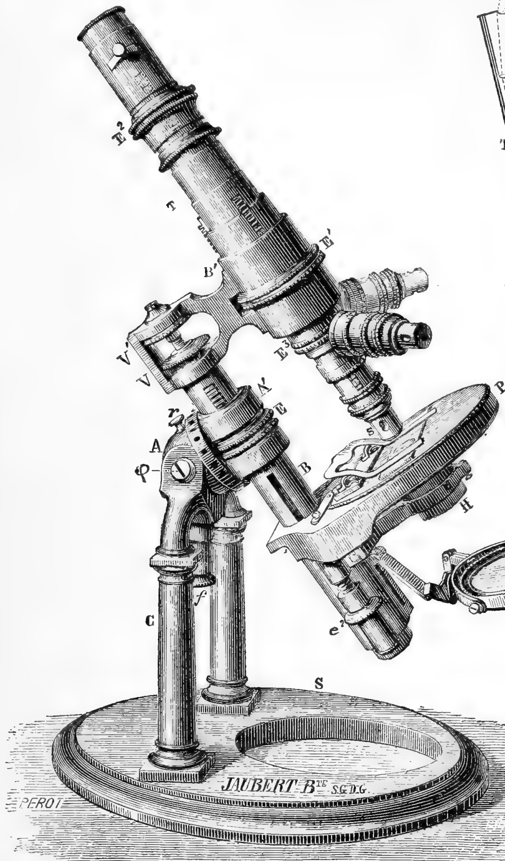
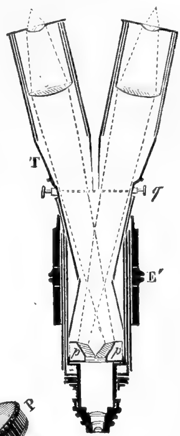


FIG. 156.



so that it can be placed in any position, vertical, horizontal, inclined, "reversed vertical" for chemical purposes, and laterally oblique.

Figs. are given in the specification representing the Microscope converted into a chemical, photographic, and solar Microscope.

Binocular Microscopes.—Of these, several different forms are described.

Fig. 156 "represents a binocular Microscope, with a mode of producing a variable separation of the tubes, and having a single object-glass; adjustment of the focus is effected by means of the screw collar E^1. The tubes T are after crossing again united at their lower extremities by two hinges, and may be separated at their upper extremity by means of the reversely threaded screw at *q*. The two prisms *p p* which divide the rays coming from

the object-glass follow the motion of the tubes upon their hinges. One of the two prisms is placed a little higher than the other, in order that the rays may not pass between their angles, which may in this manner cross each other more or less."

Fig. 1, plate XII., represents a front view of another binocular Microscope. The variable separation of the tubes t, t, as well as their drawing motion, take place by means of the milled head E^1, and by the pinions i taking into racks fixed upon each of the interior tubes. The prism p^1, which is conical, circular, concave, and truncated, reverses the image by causing the rays to pass to the left which it has received from the right, and those to pass to the right which it has received from the left.

Figs. 2, 3, and 4 " show other arrangements of prisms or reflectors either plane or curved, the object of which is to divide into two parts the rays coming from an object-glass of any kind, and to render them binocular; this arrangement allows of the visual angle being preserved and the angle of the two eye-tubes being equalized. Although two of the prisms or reflectors are not placed in the same plane, they have nevertheless no influence upon the extent of the luminous rays and the dimension of the rays which pass through them. A reverse threaded screw allows of the prisms p, p^1, being separated, and another similar screw serves also to move the prisms p, p, into the positions shown at fig. 5, and which then furnish images of another kind. With reflectors formed by a sector of a cylinder (fig. 4) images" different from the preceding are obtained, and present singular effects, " which with their applications form part of this invention."

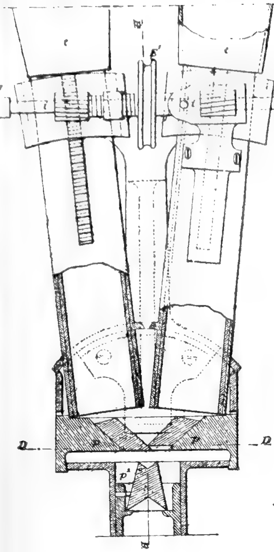
Fig. 6 represents a binocular Microscope with double object-glasses. " The two tubes are made to suit the variable distance of the eyes of the observer by turning the head of the long screw V^3, which acts by means of two different proportioned screw threads upon the arms b, b, b^1, b^1, so that the tubes t, t, can be made to recede from each other until the arms b, b^1, are parallel in two planes passing through their points of attachment, without the object leaving the focus. Each tube is furnished with revolving object-glass holders having three or four object-glasses; this might also be the case with the eye-pieces." The tubes of the object-glasses are cut away when their focus is very short.

Fig. 7 represents a portion of a Microscope for two persons to inspect the same object at the same time. The lenses are slightly cut away.

" Fig. 8 shows another modification of the binocular Microscope and is intended to give views of the same object at different angles, so that the relief of the object is considerably augmented."

" Fig. 9 (plate XIII.) shows the mode of uniting a large number of object-glasses, each of which gives a somewhat different view of the object. Figs. 10 and 11 show how all these various views may be brought to bear upon the same eye-piece or upon the same point, or upon different points. These object-glasses may be made all to magnify to the same or to different extents."

" These binocular Microscopes having one or more object-glasses, or having several object-glasses and one eye-piece, are also intended for photographing objects, and for reproducing them with forms and reliefs resulting from these arrangements. These views may be superposed completely or partially, and be of equal or different dimensions, or different views of the same object, but of such dimensions that those which reproduce the same plans shall be larger or of greater magnifying power, and the others smaller, or *vice versâ*. They may be combined in such a manner as to reproduce with incomparable perspective and fidelity the object, scene, or landscape photographed or under view, and so that



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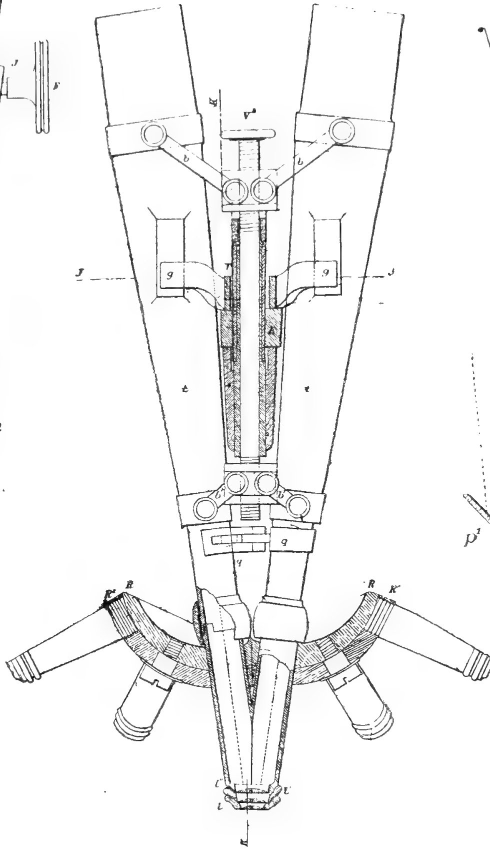

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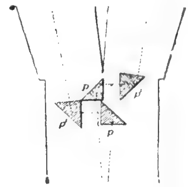

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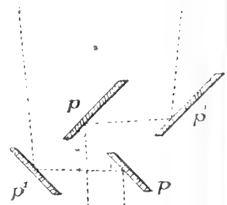

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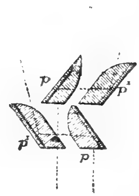

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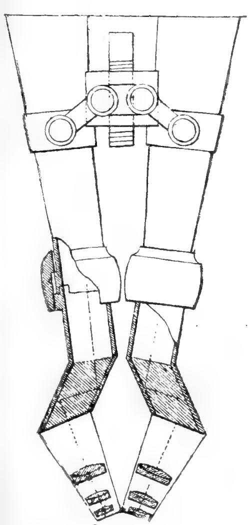

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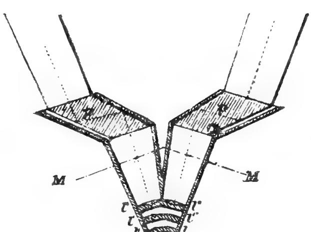

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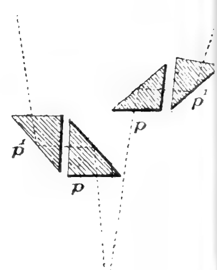

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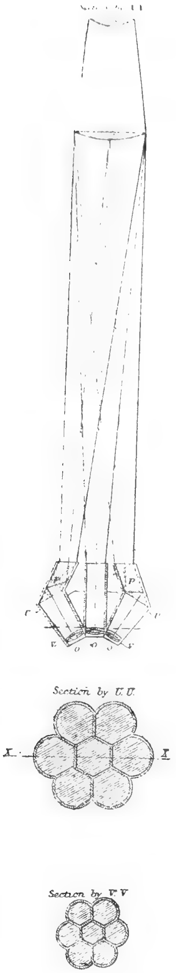
Jaubert's Microscopes, &c.



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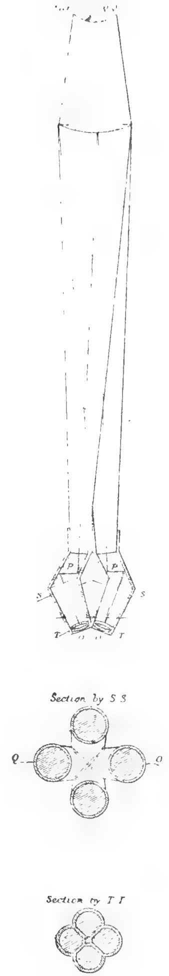

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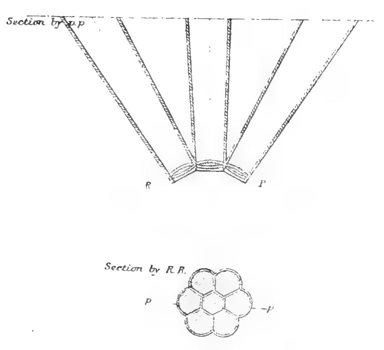

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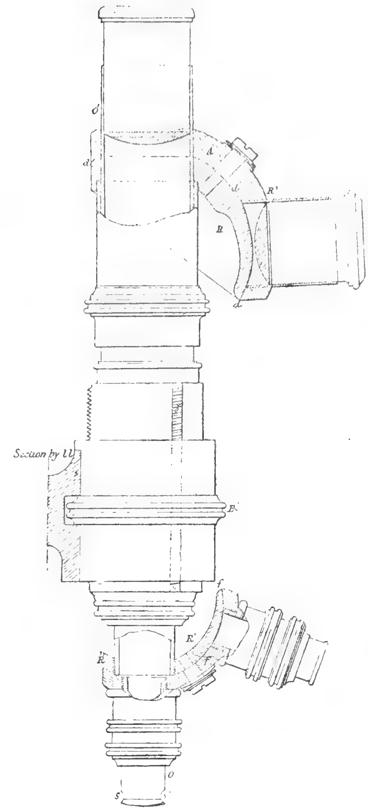

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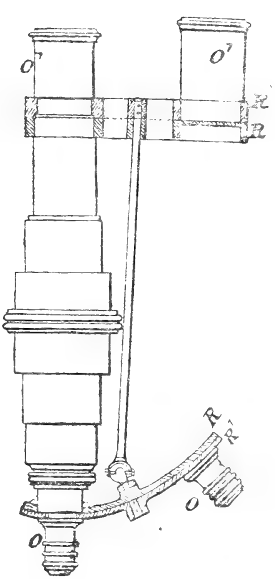

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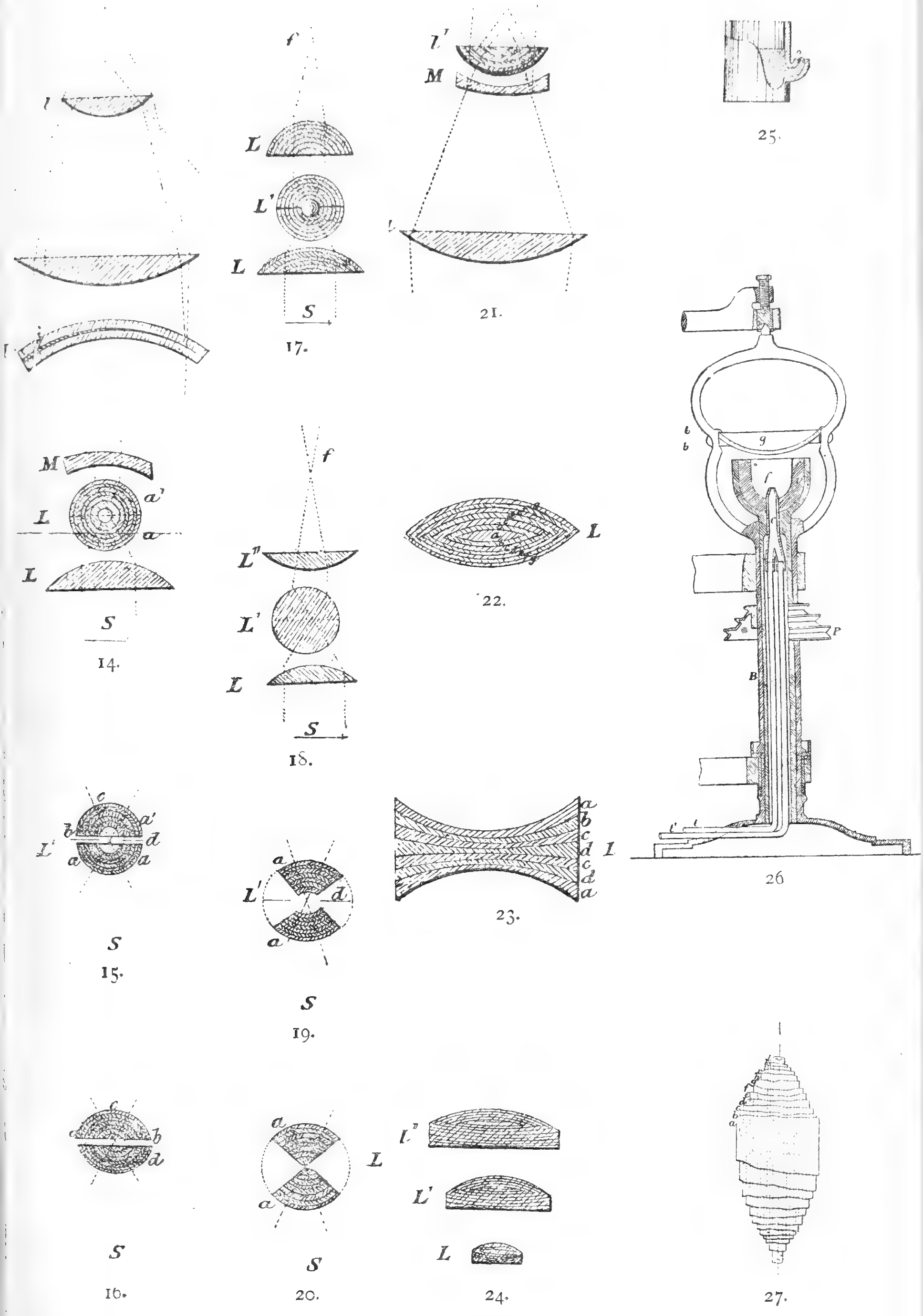
Jaubert's Microscopes, &c.



Jaubert's Microscopes, &c.

plane images drawn upon paper shall appear to be in relief as if looked at through a stereoscope."

Hand Binocular magnifying glasses are also described and illustrated.

Objectives and Eye-pieces. — In the settings there are several peculiarities. "Two openings, s s^1 (fig. 12 of plate and fig. 155), made in the outer tube of the objective, allow of the entrance of the light condensed by prisms, mirrors, or reflectors upon an opaque object even with the employment of the greatest magnifying power, even with glasses where the system of immersion is employed. Each of these openings is furnished with a small thin tube of silver or copper in order to prevent the dust from entering between the first and second lenses. This light may be polarized by means of a prism made of Iceland spar or any other polarizer, and coloured or monochromatized by a lens or plate of rock crystal."

Both objectives and eye-pieces are mounted on revolving holders *f*, with spherical bars R and R′, as shown at fig. 12. The revolving holders may be connected together by a rod, fig. 13, so that the eye-pieces and objectives may be changed simultaneously.

The "optical part" is, however, the most curious of the patentee's suggestions (figs 14–24, plate XIV.). "It is composed of lenses or series of lenses, the arrangement, form, and composition of which are special. The first lens is plano-convex; the second, which may be composed of two parts, is a complete ellipsoid, or formed of two parts of ellipsoid, or hyperboloid, or paraboloid, or even simply a spheroid. In certain cases it may be divided into two parts (fig. 15) plane or cut out at their centre, with such a curve (fig. 16) that the rays which come from the object S shall arrive at the face *d*, leave it, and after crossing each other shall penetrate the face *b*, and emerge from the face *c* after a fresh refraction, which shall render them sensibly parallel. They are rendered divergent by the periscopic lens M, fig. 14. If this lens is replaced by another which is plano-convex or a divergent periscopic meniscus (figs. 17 and 18), the rays will cross each other again at *f*, and the image will be again turned round. The lens, instead of having its centre cut out, may have it formed of a lump thicker than the rest; it may also be cut or shaped as seen at figs. 19 and 20. The lenses may be neither complete ellipsoids nor hyperboloids, and may be set at variable distances (figs. 16, 19, and 20). The lenses L, L^1, are shown on a scale larger than the real size. This arrangement of object-glass is applied in all its variations to all optical apparatus to which it may be applicable, especially to photographic apparatus, as well to simple as to compound ones, which will be hereafter alluded to."

"The improved eye-piece is composed of a convergent periscopic or non-periscopic meniscus, placed as shown at fig. 14, and of an ordinary eye-piece. Fig. 21 represents an eye-piece in which the divergent periscopic or non-periscopic glass is placed near the eye-piece."

"All the improved lenses are composed of glass in simple concentric layers, or in groups laid one upon the other and rendered adherent or fastened together, and arranged under conditions of thickness, arrangement, curvature, dimensions, and powers of refraction and dispersion even variable from the centre to the edge, such that not only are they completely achromatic, but moreover, whatever may be their form, even spherical, they may be completely deprived of spherical aberration, chromatic aberration, astigmatism, and distortion, and give the chemical focus at the same mathematical point as the optical focus. These layers, either coloured or not, are applied to the glasses of all optical instruments, spectacles, eye-glasses, field-glasses, and telescopes, and not only will these superposed

layers of analogous form and arrangement serve in certain cases like that of the animal crystalline lens, and in other cases simply superposed serving for the production of complete achromatism, but also under certain circumstances arranged in a manner contrary to the preceding arrangements they will serve to produce the maximum of chromatism and the separation of the chemical focus or optical focus, or even of the entire or partial spectrum or the neutral tints, &c., for the production of the effects of polarization and interference."

"Fig. 22 represents a double convex lens formed of concentric layers, the chemical and optic foci of which meet at the same point without aberration of any kind. Fig. 23 is a double concave of the same arrangement. Fig. 24 represents an object-glass composed of a series of three lenses achromatized by concentric layers superposed, and in the form of an ellipsoid, hyperboloid, or paraboloid, or simply a spheroid."

Making the Lenses.—Although somewhat lengthy, we transcribe this part of the patent in full, as it is by far the most "original" portion of the patentee's description. "In order to make the small Microscope lenses, especially for the first or object-glasses as well as the eye-glasses of the others, liquid glass is placed in a small pot or crucible formed as shown in fig. 25. The vitreous matter is passed through a small opening *o*, and by means of a blower it is blown in a state of fusion; by this means it is granulated or divided into round granules, the size of which is in proportion to the size of the opening *o* and of the blower, and to the force with which the air or gas is projected through the fused material. Instead of air or gas high-pressure and superheated steam may be employed, or a stream of water or other liquid at a high pressure and at a suitable temperature. If these granules should be required to be slightly flattened on one side a plate of metal or glass is placed in front and perpendicularly or obliquely to the plane of projection; they are then collected in hot water or any other non-inflammable liquid, or in any other manner, and annealed or fired if need be, and achromatized in the manner hereafter to be described; there may be any number of openings *o* and also of blowers that may be thought desirable.

"The following are the processes for manufacturing the improved lenses with concentric layers having variable refractive and dispersive powers from the centre to the edges, and which process is applicable to the manufacture of lenses of any form and dimensions, spherical, parabolic, elliptical, and hyperbolic, concave, or convex. By means of the apparatus represented at fig. 26 the form and thickness of the lenses from the centre to the edge and their curves may be varied at pleasure according to the degree of density or liquidity of the glass. This apparatus is composed, first, of a hollow fixed foot carrying the bell-shaped vessel made of fire-brick, and having openings for the pipes t, t^1, into its interior for conducting hydrogen or other gas and condensed air into the blow-pipe c, at the orifice of which they are ignited; second, of a shaft B, which may be driven at a rapid speed by means of the pulley P in communication with friction gearing; it carries a capsule or cup g, made of platinum or fire-clay. This cup may be either concave, as in fig. 26, or convex, or of any other form, according to the form of lens required to be produced. A drop or lump of liquid glass is to be placed upon the cup g, the apparatus is set in motion, and when one layer has received the required form the fire is moderated and the apparatus stopped, and the second layer of liquid glass of the same or of different density is laid thereon, and the operation is continued as before, and so on until the lens has been brought to the required form, thickness, and density. The various vitreous matters in

fusion may be taken from the pots (placed in the furnace for that purpose) with a platinum brush, the handle of which is hollow, and through which ignited air and gases are caused to pass into the wires of the brush, so that the matter being kept at the required temperature has not time to solidify, and may be laid upon the lens placed upon the preceding apparatus, when stationary, in the same manner as a layer of any other substance, such as paint, would be laid on. Plates of suitable thickness and forms in crown and flint glasses may also be prepared by blowing and moulding, as hereafter described, and caused to adhere together; for this purpose the arrangement of tubes t, t^1 (fig. 26) is employed, fed by air and hydrogen gas or any other combustible giving a flat fan-shaped flame. Pincers having two or three jaws are held in each hand for the purpose of holding the plates to be united; when the faces to be united have been softened they are brought in contact through the flame, the pincers being continually kept turning. In the case of periscopic convex plates, the one which is to take the form of the other must be softened on both faces. The handles of the pincers and also that of the platinum brush have a tube like that of the blow-pipe *c* for the passage of air and gas which passes through them, the flame impinging upon the back of each plate at the same time that the flame of the intermediate burner impinges upon the two faces; this arrangement allows of one of the plates being sufficiently softened to take the form of the other.

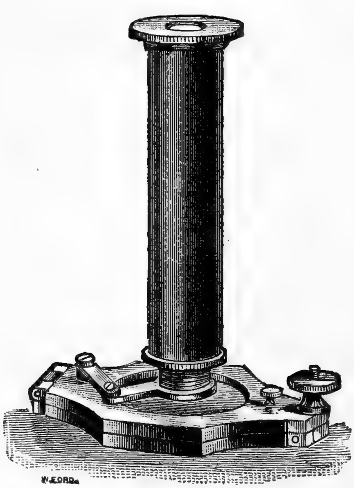
"If the plates are of somewhat large dimensions the pincers are mounted upon a lathe to the mandrils of which a rotary motion of greater or less speed is imparted, and also a reciprocating motion. One of these shafts may advance one of these two plates upon the other; seams and inequalities are caused to disappear by the softening of the glass combined with the motion, but if the lenses to be produced are of large dimensions the preceding processes might be partly insufficient, and in that case plates are employed of the dimensions, forms, thickness, and refractive and dispersive powers suitable for the effect desired to be obtained. They are laid over one another one by one, and set in a mould of polished clay which is introduced into an annealing oven and left there until the plates all adhere. If the lens is to be of any other form than plano-convex the mould has a heavy cover glazed inside, which bearing upon the lens, imparts to it the form (either convex or concave) which it has itself. A greater or less degree of pressure may be employed in order to expedite the adherence and increase the density. If, seeing the various kinds of glass (crown and flint) employed fluid or in plates, and seeing the curves of the lens and the length of focus which might be required, achromatic lenses free from aberrations of any kind could not be obtained, groups might be employed formed of layers superposed and afterwards united as simple plates. If required, fluxes might be interposed between the plates or upon the exterior surfaces of the lenses with the platinum brush. These fluxes may be composed as follows:—One part of white sand, three parts of minium, 0·5 of calcined borax, or three parts of white sand, one part of minium, and five parts of calcined borax, or others, according to the effect desired to be obtained. Instead of these fluxes pulverized glass (either flint or crown) is employed especially upon exterior plates, by means of the fan-shaped burner; this powder is brought into a state of fusion, and the required form is given to it by a suitable movement. Bevelled plates which are partially superposed, or concentric circles and plates, the bevels of which overlap, may be employed, so that the index of refraction shall vary from the centre to the edge. Instead of these circles or plates, or concurrently with them, annular parcels or fagots of glass

threads of flint or crown glass of various densities are placed concentrically one in the other, and superposed or not at their extremities. These circles or parcels of threads are made of any thickness; the threads of glass may also be placed vertically.

"The refraction and dispersive power is also caused to vary in lenses, the density of which is variable from the centre to the edge, by placing tubes formed of glass of different densities, as flint and crown glass, figs. 27, *a*, *b*, *c*, *d*, *e*, one inside the other, which are softened by heating and again blown. Other tubes of greater density *f*, *g*, *h*, *i*, are placed inside them, softened, and again blown. Tubes *j*, *k*, *l* are again put in until the whole and the centre are well filled, they are again softened and drawn, and a cylinder is obtained. If drawn with sufficient rapidity the whole of the concentric cylinders will only form a single cylinder of greater or less thickness, or if the cylinders interposed are sufficiently numerous, a convex lens cut from this cylinder will be deprived of spherical aberration and even of chromatic aberration if the density augments from the edge to the centre, if concave it will be also deprived of aberration, if the density augments from the centre to the edge. These tubes, brought at their extremity to the point of fusion, may be blown, and Microscope lenses will be formed that will be in concentric layers and will be achromatic and without aberration. By bringing them to the point of fusion lenses may in this manner be produced, the outer layers of which will be less dense and have the form and arrangement of layers analogous to those of the crystalline lens of the human eye and will be achromatic.

"Under certain circumstances concurrently with the plates, circles, bundles, and fluxes, silicates in solution in hydrochloric acid or hydrofluoric acid may be employed diluted with water or combined with other transparent substances either to cause the plates to adhere together or to obtain the required degree of refraction or dispersion. Intermediate layers of crystallized boron, sesquichloride of carbon, crystallized or melted silicic acid, bichloride of tin, small crystals, and even powder of any kind, principally powdered glass, either colourless or of many colours, obtained by the method of granulation above described, are applied by means of heat and pressure, currents of electricity, and other mechanical and chemical forces aided by blowing, moulding, and motion. By these means all the required forms and qualities are obtained, so that the refrangibility, dispersion, transparence, malleability, density, hardness, and elasticity of these lenses may be varied."

Fig. 157.



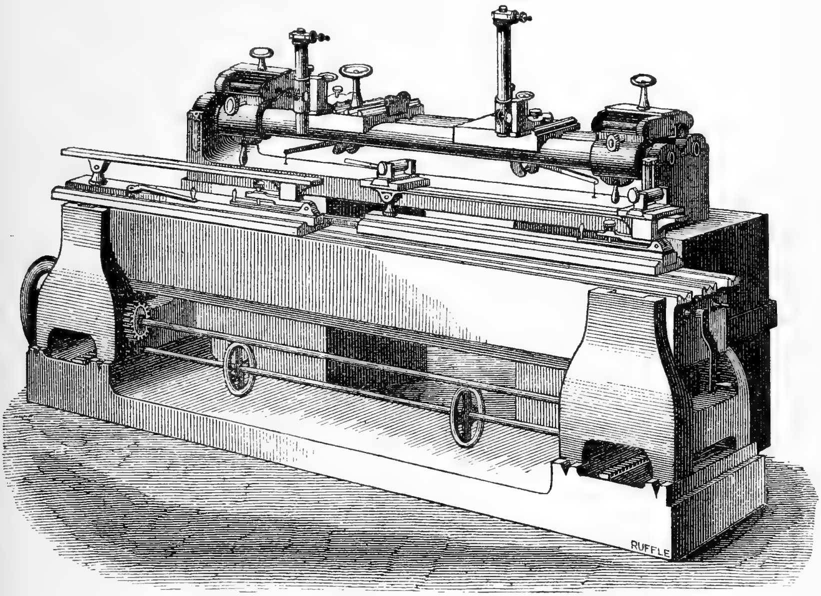
Amongst other matters dealt with are a screw guide for sliding tubes, adjusting screws with differential threads for slow or rapid motion, a universal joint to foot with clamp, improved stages, &c.

Bausch and Lomb Optical Co's Trichinoscope.—Another form of this instrument (described Vol. II., 1882, p. 258) is shown in fig. 157, the doublet being replaced by a compound Microscope which is combined with the compressor (described Vol. III., 1885, p. 714).

The original form with the doublet is on the whole decidedly preferable, and forms a convenient pocket Microscope for field use in collecting Infusoria, algæ, &c.

Rogers-Bond Universal Comparator.*—The special features of the Universal Comparator (fig. 158), devised by Prof. W. A. Rogers and Mr. G. M. Bond, are, as its name implies, the variety of the methods employed and the range of work that can be done in comparing standards of length; each independent method, when carefully carried out, producing similar

FIG. 158.



results which serve to check or prove the comparisons. It includes a method for investigating the subdivisions of the standard by comparing each part of the total length with a constant distance, determined by two adjustable stops.

A heavy cast-iron base is mounted upon stone-capped brick piers, giving a permanent foundation to the apparatus. Upon this base, and reaching from end to end, are two heavy steel tubes 3 in. in diameter, ground perfectly straight, and made "true" by a system of local corrections after they are firmly secured upon the bed-plate of the machine, the object being to get a straight-line motion of the Microscope plate, which slides freely on these true cylinders. Flexure of these cylindrical guides is provided for, by lever supports at the neutral points. Fitted closely to these guides, and outside of the range of motion of the Microscope plate, are two stops, one at each end, as shown in the figure. The stops are arranged to be adjusted at any desired position along the guides, and are

* Description supplied by Prof. Rogers. Cf. also Proc. Amer. Acad. Arts. and Sci., xviii. (1882–3) pp. 287–398 (7 figs.). Journ. Franklin Inst., cxvii. (1884) pp. 361–5 (2 figs.).

securely held by clamping on the under side. These stops are each provided with a pair of electro-magnets, the poles of which do not come in contact with the armature seen at either end of the Microscope plate. The magnets are intended to overcome the unequal pressure due to ordinary contact, a rack and pinion being used to move the plate. The magnets are used to lock the Microscope plate at each end of its traverse between the stops.

Beyond the main base just described, and supported also on brick piers, is an auxiliary cast-iron frame, which is provided with lateral and vertical motion within limits of zero, and 8 in. and 10 in. respectively, for rough or approximate adjustment, and upon the top of this frame are two carriages, which slide from end to end, a distance of about 40 in. Upon these sliding carriages are placed tables provided with means of minute adjustment, for motion lengthwise, sidewise, and for levelling, thus permitting the adjustment of a standard yard bar quickly, and without the necessity of its being touched with the hands after being placed upon the table until the work of comparison is completed.

The tubes of the Microscopes are 12 in. long and $1\frac{1}{4}$ in. diameter with eye-piece micrometers, and the objectives are fitted with Tolles's illuminating prism just above the lower lens.

This method of illumination has proved to be invaluable in the work of comparing line measure standards, especially so in the case of bars having lines ruled on polished gold surfaces at the bottom of wells sunk one-half the depth of the bar.

The first operation in the use of the comparator is to level the main base; then sliding the Microscope plate from end to end of the steel tubular guides—having the Microscope adjusted so as to be in focus upon the surface of the mercury held in a shallow trough, over which the Microscope passes—the curvature due to flexure of the guides is determined, and may be compensated for by counterweights at the various points of support.

In order to test this right-line path of the Microscope plate, the following method is employed. A fine line is traced upon the plane surface of a standard bar, extending throughout its entire length. This is accomplished by means of a cutting-tool attached to the Microscope carriage. Then, reversing the position of the bar, a second line is traced near the first, care being taken to have the distance between the two lines of each end a constant quantity. If the distance between the lines is a constant at every point, it is safe to assume that the horizontal curvature is insensible.

The extent of the effect of any horizontal curvature in the cylindrical ways may also be found by comparing the lengths of two standards placed at varying distances from the centre line between the ways.

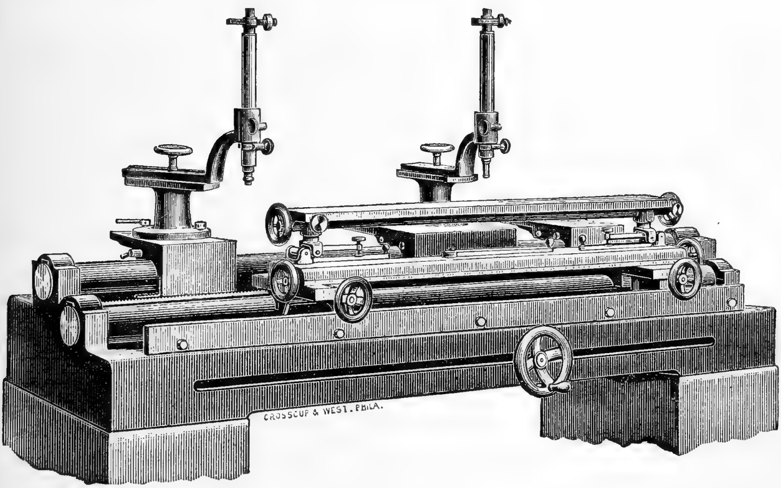
While the comparator has all the conveniences belonging to the ordinary method of comparisons by means of two Microscopes, preference is given to the "stop method." The adjustable "stop plates" are first set approximately at a distance apart equal to the lengths of the standards to be compared. The Microscope plate having been brought into contact with the left stop, the reading of the micrometer is made for coincidence with the initial line of the standard. The carriage is then placed in contact with the second stop and the reading for coincidence with the terminal line is then taken. The bar to be compared now takes the place of the standard, and micrometer readings are made as before. The difference between the results of these micrometer readings gives the difference between the lengths

of the two standards, since the distance between the stops may be considered constant for the short interval of time required to make the comparisons. It is the experience of Prof. Rogers that the precision of the contacts is about four times as great as that of making coincidences between a line of the scale and the micrometer line of the Microscope. The experiment of making one hundred successive contacts and coincidences has been frequently made without observing a single instance in which a variation from constancy under a 1/4 objective could be detected.

In the employment of the "two Microscope method," the comparator has a convenient auxiliary attachment for observing the graduations when the graduated surface is in a vertical plane, according to the method first used by Lane of the U.S. Coast Survey.

A modification of this form of comparator, made by the Ballou Manufacturing Company, of Hartford, Conn., from the plans of Prof. Rogers, for Prof. Anthony, of Cornell University, is shown in fig. 159. The instrument is mounted upon a single heavy base. Though not having the range of motion in the adjustable supports for the standard bars possible with the original comparator, it possesses all of the conveniences for rapid adjustment and accuracy of movement. The right line motion of all moving parts longitudinally is governed by heavy cylindrical guides, and the same

Fig. 159.

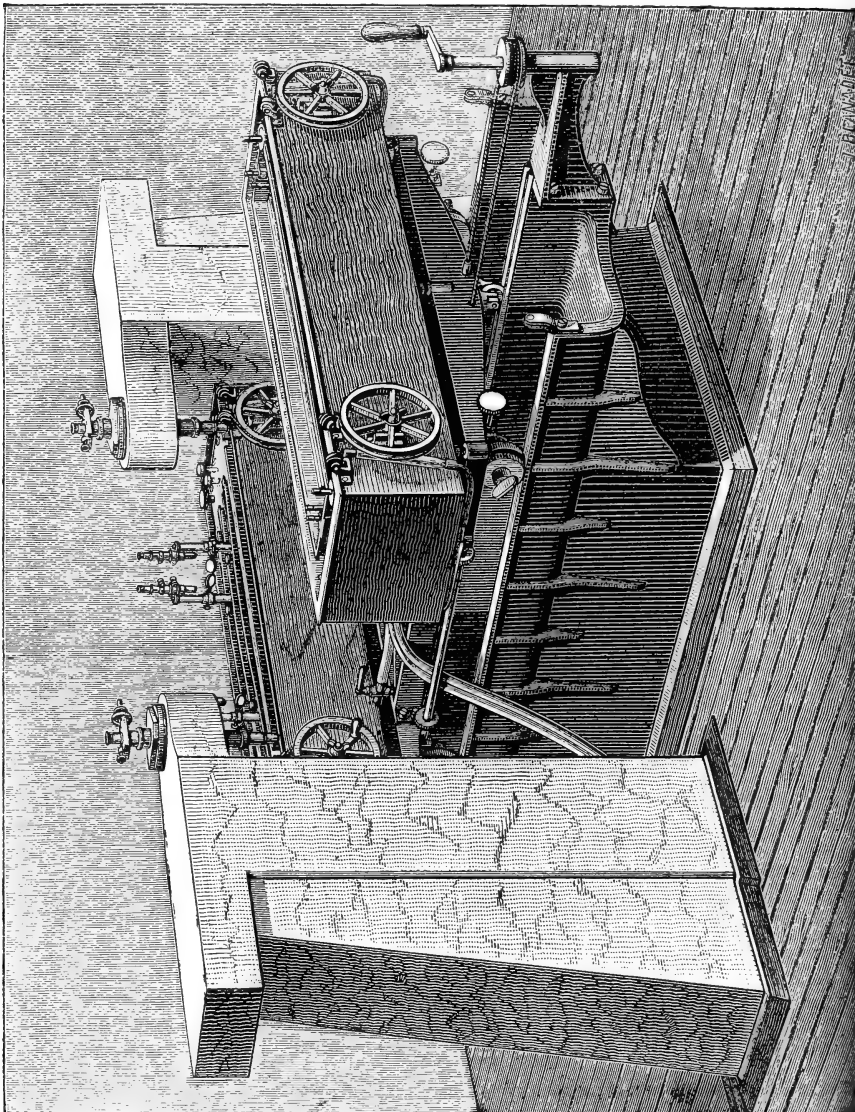


method of the "stops" is used in the comparison of either line or end measure standards of length. In this form of the comparator an effort was made to reduce the cost of construction without impairing the efficiency of the apparatus. The reduction effected in the cost was very considerable. The instrument shown in fig. 158 cost 2500 dollars, while that shown in fig. 159 cost only 800 dollars.*

* Cf. also a paper by Prof. W. C. Unwin, "Measuring-Instruments used in Mechanical Testing," Proc. Phys. Soc. Lond., viii. (1887) pp. 179–84 (3 figs.).

Geneva Co.'s Comparator.—The Geneva Society for the Construction of Physical Instruments constructed for the Bureau International des Poids et Mesures, at Paris, the comparator shown in fig. 160, for determining the co-efficients of dilatation of divided metre scales. In this four Microscopes are made use of.*

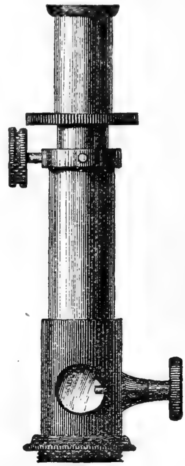
Fig. 160.



* Cf. description in the 'Mémoires du Bureau International des Poids et Mesures.' The two Microscopes on the stone pillars were made by MM. Brunner Frères, of Paris.

Geneva Co's. Reading Microscope.—In this Microscope (fig. 161) designed more particularly for astronomical purposes—the determination of the nadir with a mercury bath—the principle of the "Vertical Illnminator" is made use of for illumination.

Fig. 161.

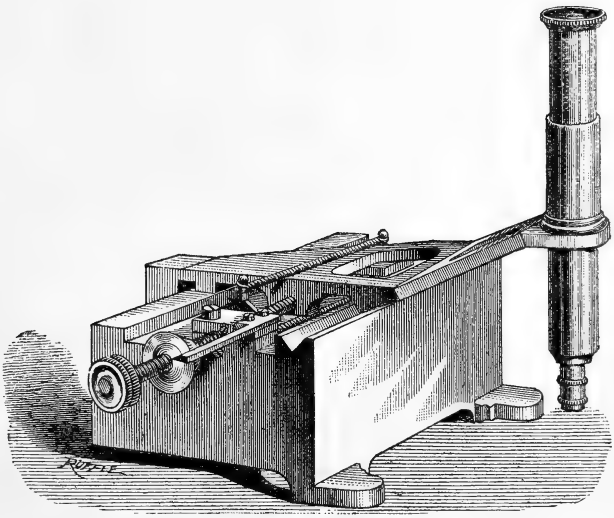


Just below the 1 in. objective is a circular opening which admits light to a piece of thin cover-glass, which is supported on an axis which passes out at one side and terminates in a milled head. On setting the thin glass at the appropriate angle, light is reflected on the object under examination, while at the same time the glass does not obstruct the observer's vision through the eye-piece and objective. The upper milled head clamps the body-tube in the socket when it has been adjusted to the proper focus. The whole instrument is 4 in. high.

Cambridge Scientific Instrument Co.'s Reading Microscope.— This (fig. 162) is also intended for reading off measurements by the aid of a compound Microscope. The one figured has a single Microscope only, but some are supplied with two.

The Microscope slides in a socket attached to a frame which moves in a deep V-shaped groove on the top of a heavy open brass support. A micrometer screw acting against an upper and lower spiral spring moves the Microscope laterally, the extent of movement being indicated on a horizontal graduated bar, the periphery of a coned nut on the screw axis

Fig. 162.

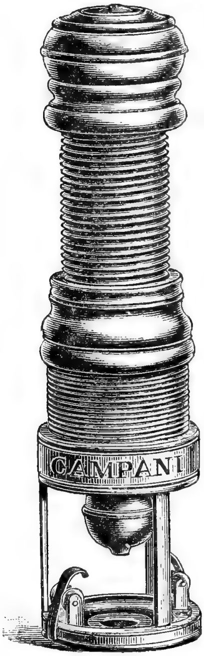


serving as the index. Fractions of divisions are recorded by graduations on the nut itself, the bar, which has a bevelled edge, here acting as the index.

Campani's Compound Microscope.—One of the earliest opticians known to have made a specialty of the construction of Microscopes was

Giuseppe Campani of Rome, who flourished in the latter half of the 17th century, when he was regarded as one of the most skilful makers of telescopes in Europe, outrivalling Eustachio Divini of Bologna, and in technical perfection of optical work not unworthy to rank with Huyghens. His Microscopes have now become so rare that we need hardly plead any other justification for figuring one of them (fig. 163) which we met with during a recent visit to Italy, and which is the first (to our knowledge) that has been figured.*

Fig. 163.



The body-tubes are of wood, and are provided with a double focusing arrangement, one (the lower) for regulating the distance between the object-lens and the object by screwing into the metal ring-socket supported on the tripod, the other for varying the distance of the eye-lens from the object-lens by a screw-motion of the upper tube within the lower one. The base consists of two plates, the upper one being attached to the tripod and the lower one being held to the former by the lateral pressure of a bent spring on either side travelling on rollers, the object-slide being placed between the plates, which are perforated in the centre so that the object may be viewed by transmitted light.

The object-lens is bi-convex, of somewhat yellow glass, and about 1/2 in. focus, and is held in a wood cell by a perforated cap, which serves as a diaphragm. The eye-lens is bi-convex, of about 1 in. focus. There is no field-lens, and hence we think the date of the construction may with some probability be assigned as prior to that of Hooke's compound Microscope (vide his 'Micrographia,' 1665), in which the application of a field lens was claimed as a novelty. In confirmation of this point we may note also that in 1667 Hon. Fabri, in his 'Synopsis optica' (4to, Lugduni), Prop. 46, described a compound Microscope by Divini, in which two pairs of plano-convex lenses were used for the eye-lens and field-lens respectively, so that the application of a field-lens to the eye-piece of a Microscope was known in Italy at that date. Divini's Microscope was also fully described in the 'Giornale de Letterati,' i. (1668) pp. 52–4, which description was partly translated in Phil. Trans., iii. (1668) p. 842, and must have become widely known.

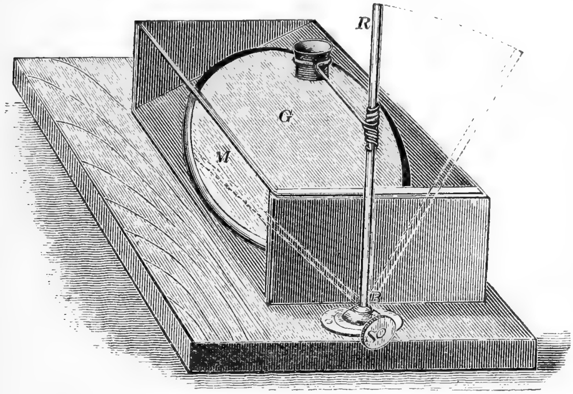
James's Dissecting Microscope.†—Dr. F. L. James uses a cigar-box from which the top and front side have been removed, an old hand-mirror, and a plate-glass cover (fig. 164). In use, this stands on a board which carries an upright rod, provided with a ball-and-socket joint. On this rod slides an arm made of wire, twisted so as to hold a watchmaker's eye-glass. When not in use the ball-and-socket joint permits this rod to be turned down out of the way. The object to be dissected or slide to be arranged is placed on the plate-glass cover. The light is thrown upward by the mirror and through the cover-plate, so as to render visible the minutest detail of

* Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form) 1886, p. 10 (1 fig.).

† Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 145–6 (1 fig.).

the object to be arranged. In fact the entire combination is a sort of mounting and dissecting Microscope on a large scale.

Fig. 164.



Bausch, E.—**Two new combined inverted and vertical Microscopes.**
[Describes the Microscopes noted *ante*, p. 141.]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 148–9 (1 fig.).

Competition for the best Microscope.
[" Notes from our London Correspondent." " Certain amateurs of the Microscope in London have been recently discussing the advisability of proposing a competition among opticians : (1) for the best stand for the highest class of work; (2) for the best stand to be supplied for a given sum, say 20*l.*; and (3) the best student's Microscope, costing, say, 5*l.* The suggestion is that a handsome gold medal might be awarded for the best instrument in each class. Special precautions would doubtless have to be taken in the two latter competitions to insure the strict fulfilment of the conditions as to the cost of the instruments. A jury would have to be named comprising microscopists of known skill in the use of the instrument, and one of the principal conditions would be that every Microscope would be put through its paces by one or other of the jury—*not* by the opticians or their nominees. If this matter could be brought to a focus I hope the American opticians will join in the competition. The intention is to arrange the fairest possible conditions, so that the awards may carry the highest possible authority."] [Nothing has been heard of this here !]
Queen's Micr. Bulletin, IV. (1887) p. 17.

Czapski, S.—**Die Mikrometerbewegung an den neueren Zeiss'schen Stativen.** (The fine-adjustment to the new Zeiss stands.)
[Same as Journal, 1886, p. 1051, but different fig.]
Zeitschr. f. Instrumentenk., VII. (1887) pp. 221–2 (1 fig.).

Nagura, O.—**[The Choice of a Microscope.]**
[Japanese.] *Tokio Med. Journ.*, 1886, No. 420.

Nelson, E. M.—**New Microscope.**
[Original description. Cf. this Journal, *ante*, p. 292.]
Journ. Quekett Micr. Club, III. (1887) pp. 85–8 (1 fig.).

Stricker, S.—**Demonstrationen mit dem elektrischen Mikroskop.** (Demonstrations with the electric Microscope.) *Wiener Med. Bl.*, IX. (1886) No. 39.

(2) Eye-pieces and Objectives.

"**New Glycerin Immersion Microscopic Objective.**"—We have been favoured by a firm of Manchester opticians with a copy of a notice under this heading in which the following statement is made :—

" Their experiments and experience prove glycerin to be a much better medium than water or oil. Water necessitates the Microscope being used

almost upright, and soon evaporates. Oil requires great care in manipulation and loss of time in cleaning off after use. *Glycerin is free from these objections.* It will remain three or four days limpid and free from evaporation, and only requires cleaning off with a camel-hair pencil dipped in water, and the lens dried with blotting-paper. This objective has more brilliant definition, deeper penetration, and a greater working distance from the object than any others of its class at much higher prices."

It is not a little surprising that in these days an optician should show such a want of appreciation of elementary optical principles. Glycerin having a lower refractive index than the oil used for immersion the objective is not a homogeneous-immersion objective, with which, therefore, it cannot be compared. Glycerin having a lower refractive index than the fluid used for homogeneous-immersion, the aperture of glycerin objectives, and with it the brilliancy of the definition, is necessarily reduced. The "deeper penetration" is of course simply a function of the reduced aperture. Why a glycerin objective should have a greater working distance it would puzzle an optician to say.

Apart from optical errors, it is equally erroneous to say that glycerin requires less care in manipulation and takes less time to clean off than oil, while its well-known tendency to absorb moisture, and therefore to change in index, is more than a compensation for its alleged freedom from evaporation. It will be news to many that "water necessitates the Microscope being used nearly upright."

Notwithstanding the glowing panegyric on this objective the notice of its virtues, although stating that it is a 1/16 in., omits any mention of its aperture.

Zeiss's Objective-changer, with slide and centering adjustment.—This contrivance (figs. 165 and 166) is designed to provide (1) accurate

Fig. 165.

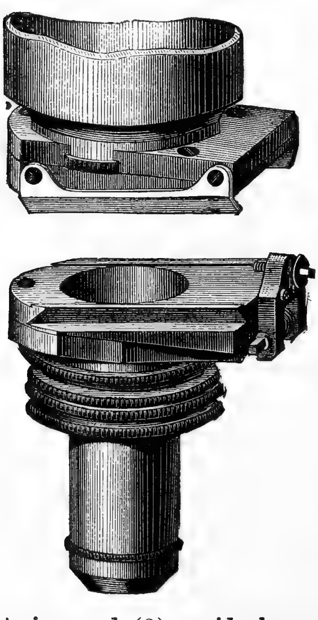
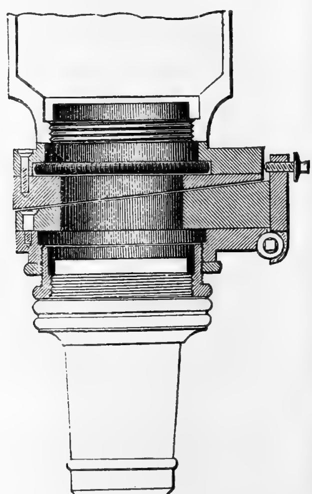


Fig. 166.



centering, and (2) rapid change of the objectives. It consists of two parts, the tube-slide and the objective-slide.

The tube-slide is screwed to the bottom of the body-tube. The plane of the sliding motion is purposely made, not at right angles to the axis of the instrument, but inclined at an angle to it, so that the objective falls and rises as it is inserted or withdrawn. In this way any danger of contact with the object is avoided. The objective is screwed to the objective-slide, and the plane of motion makes with the axis of the objective an angle which is the supplement of that of the tube-slide. At one end is a screw turned by a watch-key, which acts as a stop to bring the objective always back to the same position, and which also serves as a centering adjustment in the direction of the slide, while the adjustment in the transverse direction is effected by a similar screw working at right angles to the first.

Objectives whose settings are approximately compensated for their focal lengths can, by means of the clamp-screw on the objective-slide, be set once for all in their proper position. Any number of objective-slides may be used with one tube-slide. The two pieces fit one another accurately. The objectives always return to the same position, so that the same part of the object occupies the field of view.

HOPKINS, G. M.—**Diminishing the power of an Objective.**

["It is often desirable to diminish the magnifying power of an objective, and at the same time increase its penetration. For example, if one possesses a 1½ in. or 2 in. objective, and desires to examine objects like minerals in the natural state, crystals, seeds, &c., he will find it necessary to focus up and down upon the object to see it in all parts. A 3 in. or 4 in. objective would furnish the desired power, but it is not at hand.

To increase the focal length, and at the same time enlarge the field and deepen the focus, it is only necessary to place a double convex lens of, say, 5 in. focus about half-way down the draw-tube. The action of such a lens is the reverse of that of an amplifier."]

Engl. Mech., XLV. (1887) pp. 310–1, from *Scientific American.*

(3) Illuminating and other Apparatus.

Value of Achromatic Condensers.*—Mr. E. M. Nelson and Mr. G. C. Karop write that an achromatic oil-immersion condenser has been made for them by Mr. T. Powell (Mr. Nelson having, in 1882, suggested to him the necessity for achromatizing the then chromatic oil-condenser) and that this has enabled them to illuminate objects by solid axial cones of larger angle than before; the spherical aberrations of a chromatic condenser being so great that only the rays passing through the centre or through a narrow zone of the condenser could be focused on the object at one time. The result has been a marked increase in resolution. In illustration of this increased resolution they refer to a drawing of an areolation of the same valve of *Isthmia nervosa*, which they figured in their former paper.† The straight bars of silex, by which the central delicate perforated membrane was shown to be attached to the margin of the areolation now have a trabecular appearance; the delicate membrane extends to the edge of the large areolation, and has perforations more difficult to resolve than those in the centre.

They point out that this is not a correction of misinterpretation of optical images, but a clear case of increased resolution, due to an improvement in optical appliances. Even now they do not wish to lay any claim to finality, but to show that every advance in perfecting instrumental appliances is attended by an increased gain in our knowledge of structure. In addition to the new condenser they have used Professor Abbe's new compensating eye-pieces, which give sharper images than those of the Huyghenian construction.

* Journ. Quek. Micr. Club, iii. (1887) pp. 41–3.

† Ibid., ii. (1886) pp. 269–71 (1 pl.).

Bausch and Lomb Optical Co.'s Condenser.—The speciality of this condenser (fig. 167) is that one end of the cross-arm has a weight acting as

Fig. 167.

a counterpoise to the bull's-eye lens at the other end. The lens is 3 in. in diameter.

Miles' "Desideratum" Condenser.*—Mr. J. L. W. Miles' condenser "consists of a plano-convex lens of given dimensions, having a ground spot in the centre; to this can be superadded an adjustable plano-convex lens of short focus. These can be used with or without a system of stops and discs with openings by means of a sliding spindle, which enables any size or character of stop to be placed close under, or at any distance from the lenses.

"The following is a recapitulation of the working capabilities of the condenser:—

"The back lens, used as a simple condenser for all powers, will be found to meet all the requirements of the ordinary microscopist. With a 1/2 in. objective of 70° or 80° aperture, and a C eye-piece, *P. angulatum* can be 'dotted' readily.

"Used as a combined condenser and light-modifier, it possesses advantages superior to the devices in common use.

"As a dark-ground illuminator, it leaves nothing to be desired, working easily with powers from 3 in. to 1/2 in. of 40° inclusive; and also with the 4 in. by increasing the size of the spot-stop.

"It gives binocular vision with 1/4 in. objectives, illuminating both

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 31–3.

fields of a binocular Microscope, in use with that power, remarkably well; hence, as may be inferred, there is no difficulty whatever in illuminating both fields with all lower powers.

"In combination with the front lens it has an aperture of 110°, and will, in conjunction with a suitable stop, give dark-ground illumination, with 1/4 in. objectives, up to 100° of aperture, or with any power intermediate between that and the 1 in.

"The combined lenses, having a comparatively large aperture, will be found useful in all cases when a pencil of light of large angular dimensions is desirable, which is very seldom.

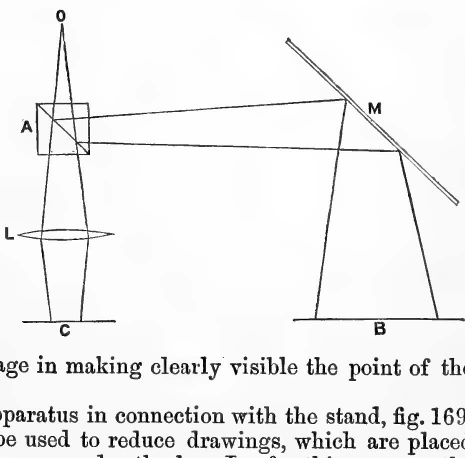
"Used with a stop having one or more side-openings, it will give unilateral or equidistant beams of light of considerable obliquity.

"Generally speaking, the stops, when used, are to be placed close under the lenses, but in practice it will be found that placing a large stop at some distance from the back lens will occasionally disclose structure when every other method fails. A unilateral beam of light, for resolving *P. angulatum* on a dark ground, is best got by placing a suitable stop *on* the back lens before screwing on the front.

"Last, and not least, of the merits of this condenser, is the low price at which it can be supplied, and adapted to nearly any Microscope. It has one fault; it is non-achromatic. This defect is not noticeable with low and medium powers. In using the combined lenses with high powers, the defect may be minimized considerably by careful focusing. Using one lens only, the defect will scarcely ever be noticed. As a matter of fact, only the most costly condensers are really achromatic. To make this into a so-called achromatic condenser would increase its cost, and render it useless for many purposes."

Nachet's Camera Lucida for Magnifiers.*—This apparatus, shown in fig. 168, consists of a glass cube A, formed of two prisms, one of which has an hypothenuse surface gilded on Prof. Govi's method. This is sufficiently transparent to transmit the rays from the object C to the eye at O at the same time as it reflects also to the eye the rays from the paper B and mirror M. The doublet or single lens is at L. The images are of two different tints, the one seen through the gold film being emerald green and that seen by reflection yellow. The difference of colour is said to be of advantage in making clearly visible the point of the pencil.

FIG. 168.



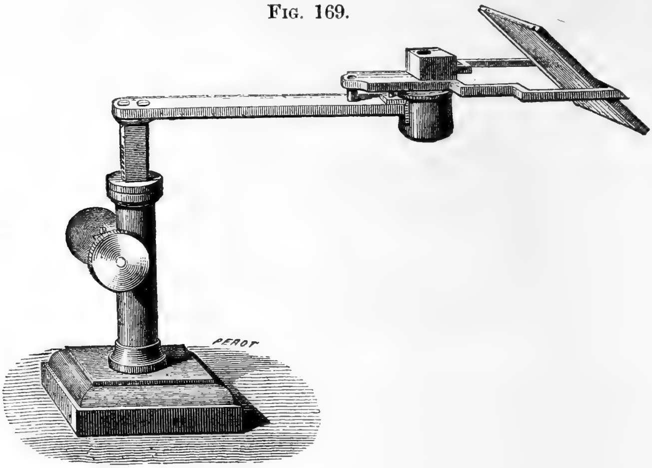
M. Nachet supplies the apparatus in connection with the stand, fig. 169.

The instrument can also be used to reduce drawings, which are placed under the mirror M and the paper under the lens L; for this purpose the mirror is made to rotate and an extra low power lens is used. As the smallest movements of the pencil are followed by the lens, these reductions

* Robin's (C.) 'Traité du Microscope,' 2nd ed., 1877, pp. 429–31 (2 figs.).

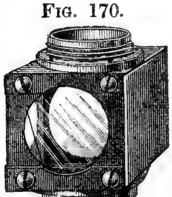
have, says Prof. Robin, "a character of precision and finish quite remarkable."

FIG. 169.



Prism for Drawing.—In accordance with our custom of chronicling microscopic apparatus actually brought to the condition of practical manufacture and use, we note this device of an anonymous designer.

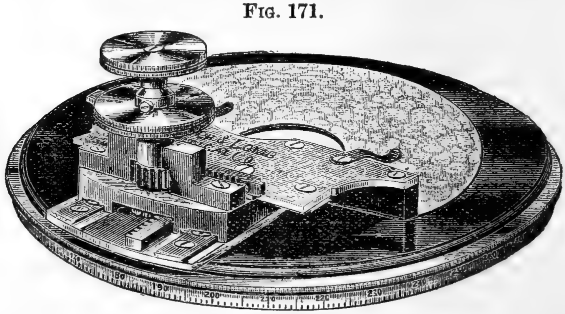
FIG. 170.



It consists of a right-angled prism, not attached above the eye-piece, but placed at the nose-piece over the objective, the image being reflected on paper placed on the table on which the Microscope stands. It cannot, however, be used with ordinary Microscopes where the body-tube is in front of the limb, but only with such forms as the Watson-Moss,* where the body-tube is at the side.

Bausch and Lomb Optical Co's. Mechanical Stages.—These are made in the two forms shown in figs. 171 and 172. Fig. 171 is $4\frac{1}{2}$ in. in diameter,

FIG. 171.



and is intended to be used with the "Concentric" and "Professional" Microscopes. It is thin, to allow great obliquity, but firm. The movements are contained within the circumference of the stage, so that it can make

* See this Journal, 1881, p. 516.

a complete rotation. The rectangular movements are delicate and actuated by two milled heads, placed one above the other (Turrell form). The upper part of the stage is polished black glass; the edge is milled, graduated to degrees and silvered.

Fig. 172.

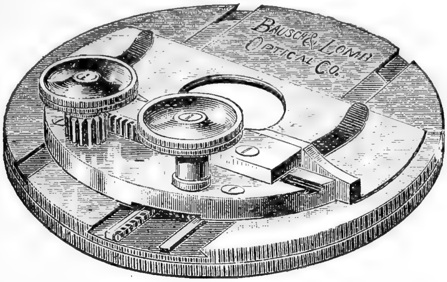
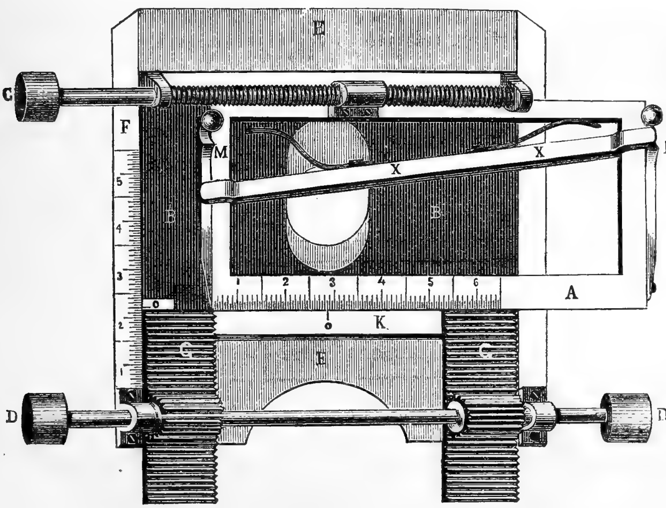


Fig. 172 can be adapted to any Microscope which will admit of a stage $3\frac{1}{2}$ in. in diameter. The movements are all contained on the upper surface of the stage, and it can therefore be completely rotated. It is thin and will admit the use of very oblique light.

Smirnow's Microstat.*—Dr. A. Smirnow describes, under the name of microstat, an apparatus which he has constructed to obviate the great

Fig. 173.



inconvenience of examining the whole of a large object under high powers, or of re-finding minute objects, such as Bacteria, in a large preparation. The purpose of the instrument is much the same, he notes, as that of Klönne and Müller's Bacterium finder.

The principle of the contrivance is based on the fact that any point

* Russ. Med., 1886, No. 27 (in Russian). Arch. f. Mikr. Anat., xxix. (1887) pp. 384-8 (1 fig.).

may be determined by its distance from two fixed points or lines on the same plane. The slide is placed in a frame A and kept always in the same position by a rod X. Before the slide is inserted the rod X is pressed forward to the anterior margin of the frame where it is held by two teeth M. By pressing the knobs of the teeth, the rod is released and springs back so as to fix the slide in a given position. The frame is moved from right to left by a micrometer screw C. On an immovable plate K, a permanent point *o* is marked, and the adjacent margin of the movable frame is divided in 0·25 mm. Thus one line on the preparation is defined. But the frame A is fixed to another movable plate B B which is worked by the rack and pinion G, D, on an inferior fixed plate E E, and in an antero-posterior direction. One margin F of this fixed plate is also graduated, and there is another fixed point *o*, so that the desired point in the field can be defined in two directions, and therefore readily determined. The plates B B and E E have apertures for illumination. The attachment to the stage is a simple matter.

The whole field can be systematically observed, a point can be registered and readily found again, the size of large objects can be measured, movements of organisms can be defined, and the comparison of lent preparations greatly facilitated.

Notwithstanding the fulness of the description and the renown of the German periodical in which it appears, it must be said that the "Microstat" is simply a mechanical stage with finders, and in this country at any rate has no feature of novelty.

Darling's Screw-Micrometer.*—Mr. S. Darling has devised two forms of screw micrometer, in which he claims there is "no perceptible play between the threads of the screw and the nut," and in which "the screw will revolve much farther, relative to the motion of the cross-hairs, than in the micrometers heretofore made;" and further, that he has found "a substitute for the common cross-hairs (spider's web), by which measurements can be made with greater accuracy and uniformity."

One form of his micrometer (fig. 174, top view, with top E removed; fig. 175, section of fig. 174 through A B) has a V-thread screw and nut, the nut

Fig. 174.

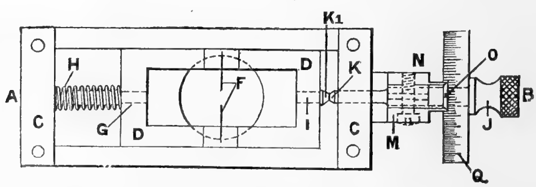
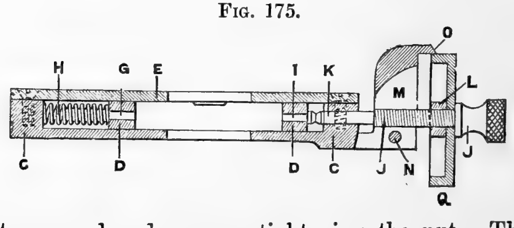


Fig. 175.



being split at one end and a screw tightening the nut. The frame that carries the cross-hairs has a very small hard abutting-piece coming against

* Specification of U.S. Patent, No. 287,420, Oct. 30, 1883.

the end of the screw; the screw also being made hard and preferably small. In another form (fig. 176 top view, with the top E removed; fig. 177, section of fig. 176 through R S), two screws are made on the same piece, each made

FIG. 176.

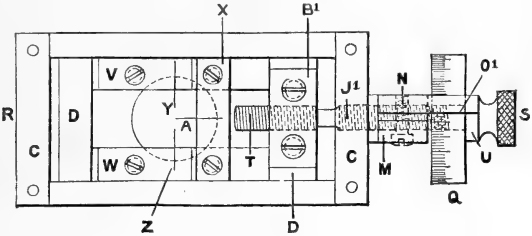
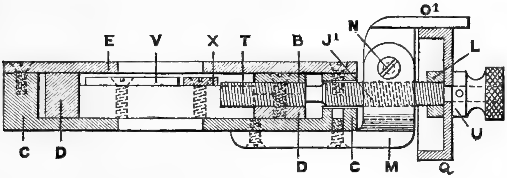


FIG. 177.



of a different pitch, and a whole or split nut for each part of the screw, one nut and the corresponding screw being attached to the frame that carries the cross-hairs.

He proposes to use wires of glass or other suitable material instead of spider-webs, and to apply short cross-wires parallel with and opposite to each other, leaving a space between them and in various positions, so that the operator can have several points to guide him in adjusting the micrometer on the object to be measured. He says,—

"It is well known to mechanics that a screw loose in the nut cannot be depended upon for great accuracy and uniformity in measurements, notwithstanding the slack may be taken up by a spring, as particles of matter are liable to get between the threads and cause errors. That difficulty is avoided in this improved micrometer. From experiments it is believed that the cross-hairs in a micrometer made according to this improvement can be adjusted to a line a number of times—say five, more or less—within an error of 0·00005 of an inch. It greatly facilitates the adjusting of the cross-hairs to a line to have the screw move a considerable part of a revolution for each division of the index-wheel. It is difficult to move the screw made in the ordinary way little enough to adjust the cross-hairs in the most accurate manner, and the difficulty in moving it little enough often influences the operator to accept an adjustment as correct with which he is not fully satisfied.

In the drawings I have illustrated a screw made in two parts on the same piece, one part being 20 pitch and the other 25 pitch, which gives a movement to the cross-hair frame of 1/100 in. each revolution, this being intended for ordinary work; but in a micrometer for very fine measurements I should use a screw from 35 to 40 pitch. 36 and 37·037 pitches would be 3/4000 in. approximately, to each turn of the screw, and the object being magnified fifteen times, and the index-wheel divided into ten parts, one division on the wheel would be 1/200,000 in., and the

index-wheel being about 1·2 in. in diameter, it will be seen that the lines on the screw or index-wheel will be over 0·35 apart, instead of one-tenth (0·035) of that, when the wheel is divided into one hundred parts, in the usual way."

"I have illustrated two methods of making micrometers, which vary from each other in some respects. One method is shown in figs. 174 and 175, and the other in figs. 176 and 177.

In figs. 174 and 175, C is a case with top removed, inclosing the cross-hair frame D. F are wires attached to sliding frame D. These wires may be made of metal or any suitable material, and should be from 1/500 in. to 1/1000 in. in diameter. Glass is a good material to make the wire of, as it can be pulled apart and a square end obtained. The wires can be secured to the frame by wax or any other suitable means. There may be one wire only, or two, as shown in fig. 174, or any number desired, and they may be placed in any position, as shown at A, Z, and Y, fig. 176, or any other preferred. M is a split nut. N is a screw for bringing the two parts of the nut together. J is a screw which passes through nut N, and terminates in a small hardened abutting-end K. O is an index-line. I is a small hardened abutting-piece attached to cross-hair frame D. G is a rod for holding spring H in position. Q is a graduated index-wheel. E is the top to the case C.

V W X, fig. 176, are adjustable pieces, to which the wires are attached; T the part of the screw which is 20 pitch; J_1 the part that is 25 pitch. The screw J_1 passes loosely through the frame C.

It will be seen that by means of the split nut and screws N all play between the nut and the screw can be prevented. Nut B′ may be split at one end, the same as nut M, or made in two parts, with two screws as shown.

It is evident that with the nuts properly adjusted the frame that carries the wires (cross-hairs), fig. 176, must move with the screw without variation. The arrangement shown in figs. 174 and 175 has the advantage of the split nut, and in addition to that very small abutting-surfaces, so that there will be much less liability for dust or oil to get between the abutting-surfaces K and I than in the usual form.

There is a great advantage in having several points to aid in adjusting the cross-hairs to a line. If the operator is in doubt whether one point coincides with the line, the other points will help him to decide directly.

In fig. 174 the nut M may be made in the frame D, as shown at B′, fig. 176, instead of being located outside of case C; but in that case the advantage of the small abutting-surfaces I and K would be lost; but it would be better than the usual form.

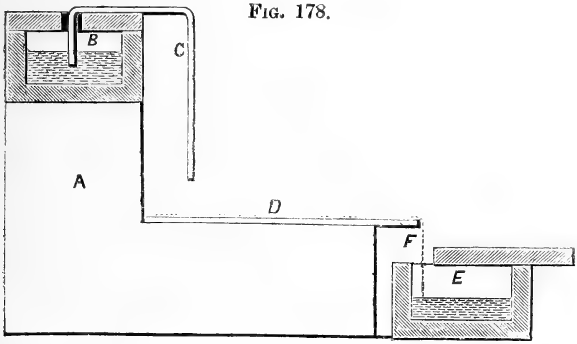
The index-wheel is divided into ten parts and each part into five fractional parts. Now, with the two pitch-screws 36 and 37·037 pitches, as above described, one division of the wheel will read 1/200,000 in., and each fractional part will read 1/1,000,000 in., for with a Microscope that magnifies fifteen times, one turn of the screw being 3/4000 and one division of the wheel being 3/40,000, and this magnified by fifteen times gives 3/600,000 = 1/200,000, and one-fifth (the fractional parts), will give the 1/1,000,000.

The advantage in using the end of a wire instead of the side of a spider-web in the usual way, is that the full size of the line is always in view, and, having the wire nearly the size of the line, it is much easier to judge when the two coincide than when the line is covered by the cross-hairs, as in the common way, and when more wires than one are used each one will serve to correct a mistake that might be made with one alone."

Pagan's Growing Slide.*—The Rev. A. Pagan's slide was designed mainly for the purpose of watching the development of rotifers and other organisms which require a constant change of water. Figs. 178–81 give the essential points of its construction, which is very simple, and so far effective as to have enabled Mr. Pagan to observe the growth of the spores of *Volvox globator* after they had been confined to the slide for six weeks, the actual process of germination taking three days to complete.

Fig. 178 is a longitudinal vertical section of the whole apparatus drawn to a scale of half the actual size. A is a wooden stand supporting a glass

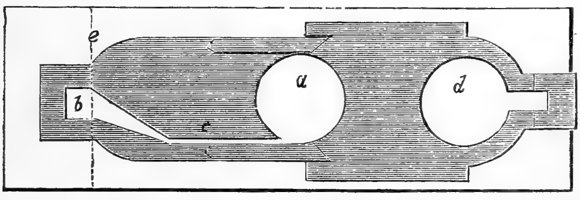
FIG. 178.



trough B, from which a water supply is conveyed to a slide D by a siphon C. This siphon is made from an ordinary capillary vaccine-tube, bent over a minute gas-flame. The water is conveyed from the slide by means of a spout F, made of blotting-paper, to another trough or suitable receptacle E.

Fig. 179 shows in full size an arrangement cut out of blotting-paper, and placed on an ordinary slide, *a* being a circular hole for containing the object under observation. This hole is connected by a narrow channel *c* with another hole *b*, shaped as in the drawing, and so placed beneath the siphon *c* as to receive a drop of water as it falls. It is sufficient, however, if the drop

FIG. 179.



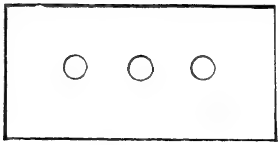
falls on the blotting-paper. A third hole *d* serves to collect the superfluous water, and also acts as a reservoir when the slide is under examination with the Microscope, water being applied there from time to time with a camel's-hair brush.

When it is desired to use the instrument, the blotting-paper is wetted and put on the slide, the drop of water containing the organism placed in the hole *a*, and the whole is covered with thin glass up to the dotted line *e*,

* Journ. Quek. Micr. Club, iii. (1887) pp. 81–3 (4 figs.).

three 3/4 in. square cover-glasses being very suitable for this purpose. The siphon may now be started, the current being regulated to about one drop per minute by means of a linen thread, unravelled, soaked in water to get rid of air-bubbles, and pushed up the shorter limb of the siphon. The water is drawn off at the other end of the slide by three strips of blotting-paper, one broad and the other two less than half the width, placed under the broad slip, thus forming a kind of channel for the water to flow through.

Fig. 180.



After a time the blotting-paper is liable to get clogged, and will not allow the water to filter through; it must therefore be changed. To enable this to be done the part used on the slide is cut in pieces in the manner indicated in fig. 179.

The form of the lid of the trough B is shown in fig. 180. It is provided with three holes drilled 1 in. apart, in order that, when desired, three separate slides can be kept under treatment at the same time.

Apparatus for examining living Myriopoda.*—M. J. Chalande employed the following simple apparatus for microscopical observation of living Myriopoda:—

Two glass slides are fixed, one over the other, by sealing-wax along the two sides, leaving a space of 1–2 mm. between the two slides to allow the myriopod to be introduced. One end of the apparatus is closed by means of a small piece of cardboard. The space between the two slides must vary according to the size of the specimens to be examined, and for very small forms the author substituted a cover-glass (32 by 12 mm. and 1/5 mm. in thickness) for the upper glass slide.

In order to give the myriopod foothold, he gummed some particles of sand to the lower slide at various distances apart. If this is not done, the animal continues to struggle, as it endeavours to find something to hold on to.

Griffith's Mechanical Finger.†—Mr. E. H. Griffith says that a cheap mechanical finger, for those who cannot afford to purchase a better one, may

Fig. 181.

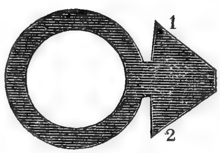
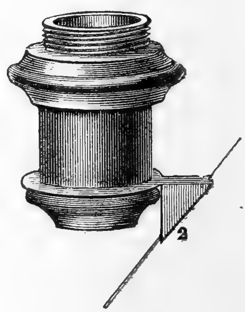


Fig. 182.

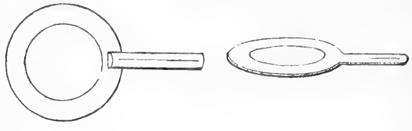


be quickly made as follows;—Procure a strip of sheet brass or other metal, and cut it like fig. 181. Make the aperture just large enough to fit over the

* Bull. Soc. d'Hist. Nat. Toulouse, 1886. See this Journal, *ante*, p. 385.
† Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 150 (3 figs.).

screw which fastens the lower system of a low-power objective to the barrel of the objective. Bend the points (1 and 2) down, so that they will meet and serve as a bristle clamp. Remove the lower system of the objective, and put in the thin brass plate as in fig. 182; then draw a cat's whisker between 1 and 2, and the finger will be ready for use as soon as the point of the whisker is in focus and in the centre of the field.

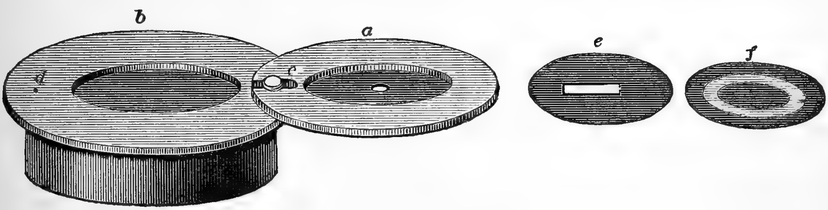
FIG. 183.



A divided wire might be soldered on the ring in fig. 182, and it would answer the same purpose (see fig. 183).

Griffith's Substage Diaphragm-holder and Glass Diaphragms.*—Mr. E. H. Griffith's holder is a metal disc *a* (fig. 184), which is to be fastened to the substage fittings *b*, by means of the screw *c*, which allows it to be turned in any position. An aperture of any desired diameter is made in the holder *a*, and provided with a ledge for the support of diaphragms

FIG. 184.



which may be dropped into position when the holder is turned on one side, as would be indicated in the fig. were the disc turned over. The slot at *c* allows the diaphragm to be placed central with the objective on a decentered stage. The screw-head at *c* should be of sufficient size to retain the holder in any position it is placed. The pin *d* is to indicate a central position when the holder is to be used on a well-centered stage.

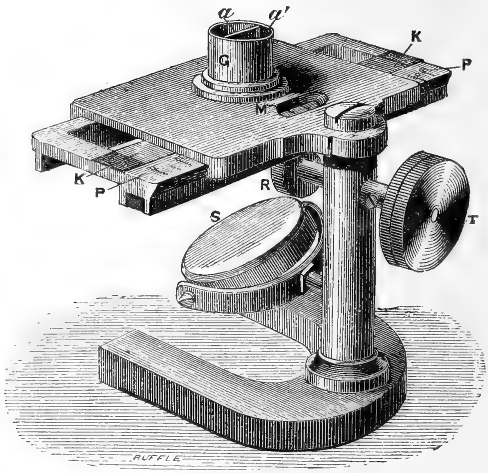
Thin metal discs with various apertures may be used for diaphragms, but much cheaper ones may be made by placing common round cover-glasses *e f* on the turntable, and with a brush quickly covering all but the desired aperture with asphalte or other pigment. In the place of diaphragms, various coloured glasses for the modification of light may be used.

Fleischl's Hæmometer.†—This instrument, fig. 185, devised by Prof. E. v. Fleischl for the estimation of hæmoglobin in the blood, is based on the colorimetric method; that is, it compares the colour of red glass with that of a solution of the blood, and from the thickness of the stratum of the solution or of the glass when the tints are the same the amount of colouring matter present in the blood is determined. Prof. Fleischl finds, however, that although it is easy to prepare a plate of red glass which has exactly the same colour as a certain thickness of a solution of blood, yet if the thickness of the plate be increased *n*-fold it no longer has the same depth of colour as a solution of the same blood concentrated *n*-fold,

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 150-1 (1 fig.).
† Med. Jahrb. K.K. Gesell. Aerzte Wien, 1885, 20 pp, and 1 pl.

or as the same solution increased n times in thickness. This peculiarity, which may totally vitiate the colorimetric method if proper precautions are not observed, is due to the fact that though the absorption of light by the glass and the blood-solution respectively are directly comparable so far as red light is concerned, there is no such direct relation for the violet

Fig. 185.



rays; hence it is absolutely necessary to eliminate the violet rays from the source of illumination, and when this is done the relation is complete for all thicknesses of the plate and the solution. For this purpose the comparison must be made not by daylight nor with electric or petroleum light, but either by candle-light or with an oil or gas flame; if this cannot be done, a plate of light-yellow glass must be interposed between the instrument and the source of light. Another feature of Prof. Fleischl's method is that the constant quantities are not, as is usual, the concentration of the solution and its thickness, but the absolute volume of the blood examined and the sectional area of the cylindrical vessel in which the solution is contained, the thickness being immaterial.

The hæmometer consists of a glass tube G, $1\frac{1}{2}$ cm. in length and 15–20 mm. in diameter, closed at the bottom by a glass plate, and divided into two semi-cylinders *a a'* of equal size by a vertical glass plate 0·5 mm. thick. The cylinder is fixed to the stage over a circular aperture, through which light is projected from the mirror S, formed of a plate of fine white gypsum. Beneath one half of the aperture is a wedge of red glass K, movable by the pinion and milled head R T, so that any part of the wedge may be brought under the aperture.

The instrument is used in the following way: the two halves of the glass tube are filled to any height with water; in one is dissolved a unit volume of the blood, and the coloured glass is then shifted until the two semi-cylinders show the same colour. The position of the wedge is then read upon the graduated scale P through the opening M in the stage, the graduations being arranged so as to give direct the percentage of colouring matter as compared with the normal proportion of hæmoglobin contained in healthy blood.

To transfer a fixed quantity of blood to the glass cylinder Prof. Fleischl uses what he calls an "automatic blood-pipette," made by dividing a fine thermometer tube into lengths of equal capacity by sliding a short column of quicksilver from one part to another of the tube and marking the glass at the ends of the column (which is not less than 1 cm. in length) with a diamond. The tube is then cut through at these points, and each length is ground to a conical termination at each end and provided with a short holder of silver wire. If the end of one of these pipettes is immersed in a drop of blood it becomes filled by capillary attraction, and a unit volume of the liquid may thus be transferred to the glass cylinder.

Measurement by Total Reflection of the Refractive Indices of Microscopic Minerals.*—M. J. Thoulet describes a contrivance for measuring the indices of minerals under the Microscope by Kohlrausch's method of total reflection. The only microscopic methods which have been employed with advantage are those of the Duc de Chaulnes and of Mallard, but in both of these it is necessary to have a section of the mineral and to determine the thickness of the section with accuracy; with Kohlrausch's refractometer it is only necessary to have a plane surface of the mineral immersed in a liquid of greater refractive index, so that a natural crystal face may conveniently be employed. In this apparatus, as is well known, the liquid of high refractive index is contained in a cylindrical vessel surrounded by oiled paper, which serves to illuminate the interior with diffused light except at the point occupied by the observing telescope, and the mineral is supported on a rotating axis, which coincides with the axis of the cylinder. When the normal to the crystal surface makes with the axis of the telescope an angle equal to that of total reflection, one-half of the field of view is illuminated by totally reflected rays. The field is consequently divided into two equal parts of very unequal intensity. If the angle between the two positions at which this occurs is $2\,i$, then i is the angle of total reflection, and the index of the mineral is $\mu \sin i$, where μ is the known index of the liquid.

M. Thoulet's contrivance is merely the total refractometer of Kohlrausch applied in a simple form to the stage of Bertrand's Microscope.† A plate of blackened brass fixed to the stage by the screws *d d* carries the graduated semicircle *s* (of which R is the axis) moved independently by the milled head A, and carrying the vernier *t* with it when moved by B. This axis carries not only the object *o*, but also the small cylindrical tube M, into the cork *a* of which it fits closely. This tube contains the bisulphide of carbon or other liquid which surrounds the object, and being completely closed prevents evaporation. M is surrounded by a second cylindrical tube N, open above, but closed below by the cork P. This tube is fixed to the holder D by a point which enters P; and D, being attached to the stand of the Microscope by the spring clip C, may be adjusted by hand to any desired position. The tube N is covered with oiled paper except along a narrow band parallel to its axis, which is brought opposite to the objective E by turning the milled head G.

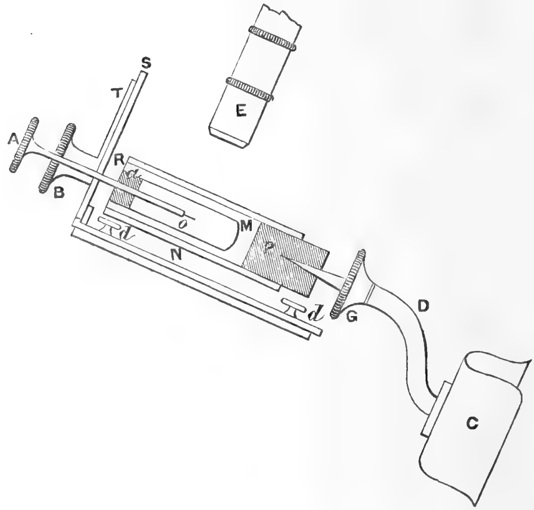
The tube M having been filled with carbon disulphide, and the object fixed at O with its face parallel to the axis (gum arabic may be used for this purpose, being insoluble in the liquid), the whole apparatus is rapidly centered and adjusted by the stage movements and those at G and C; the angle of total reflection is then determined in monochromatic light by the goniometer, which is divided to tenths of a degree, and which by

* Bull. Soc. Minéral. France, 1883, pp. 184–91 (1 fig.).
† See this Journal, 1883, p. 413.

repeated measurements gives the angle to about 2 minutes, corresponding to units in the third place of decimals.

In using the instrument the objective is replaced by Bertrand's lens for convergent light, or the objectives 0 or 1 of Nachet may be employed.

Fig. 186.



As regards the liquid, there are many objections to the use of carbon disulphide, and M. Thoulet recommends biniodide of mercury and potassium as more convenient than either naphthaline monobromide or solution of sulphur or phosphorus in carbon disulphide. In any case it will not be possible to determine an index of refraction which is greater than 1·7.

A Microscopic Advantage.

["By inverting a 1/4 in. objective over the eye-piece of the Microscope an arrangement is produced which immediately gives the images in their proper position, and not upside down, as without it. This is a considerable advantage, because it enables a worker to go straight to the object without the mistakes which so frequently occur with beginners."]

Scientif. Enquirer, II. (1887) pp. 106–7.

Hällstén, K.—**Ein Compressorium für microscopische Zwecke.** (A compressorium for microscopical purposes.)

[A brass tube surrounding the objective, at the lower end of which a cover-glass is cemented with shellac. It can be used as a compressorium, and also to prevent the dimming of high powers with water vapour when observing delicate transparent objects in the living condition on the hot stage.]

Zeitschr. f. Biol., XXII. (1886) pp. 404–7 (1 fig.).

Ketchum's (J.) Portable Oxy-calcium Lamp.

["When packed occupied a case only 13 in. long by 6 in. square. The oxygen cylinder was 3 × 12 in. long, and contained four hours' supply. The illumination was very fine."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 97.

Laboratory Notes.

[Usefulness of a simple and inexpensive eye-piece micrometer as a part of the outfit of each Microscope in the laboratory. Culture-cells made of vulcanite rings.]

Amer. Natural., XXI. (1887) pp. 477–9.

N., W. J.—**The Two Mirrors.** No. VI. *Sci.-Gossip*, 1887, pp. 75–6 (1 fig.).

Polariscope, single, for the Toy Microscope.
[Made of sixteen or eighteen cover-glasses.]
Engl. Mech., XLV. (1887) pp. 337–8 (2 figs.), from *Scientific American.*

ROGERS, W. A.—"**Microscopic metal thermometer,** by which the indicated temperature is read off upon the eye-piece micrometer of the Microscope."
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 190.

Schroeder's New Lieberkühns.
[Made of Wolfram steel.] *Journ. Quekett Micr. Club*, III. (1887) p. 92.

SELENKA, E.—**Die elektrische Projections-lampe.** (The electric projection lamp.)
SB. Phys.-med. Soc. Erlangen, 1887, 8 pp.

TATHAM, J.—**Illumination of Objects under the Microscope.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 78–9.

THANHOFFER, L. v.—**Mikroskopische Gaskammer.** (Microscopical gas chamber.)
[Contains only the following abstract—"with which the author investigated under rarefied and compressed air or in different gases the movements of the protoplasm or the circulation of the blood in small transparent animals."]
Math. u. Naturwiss. Ber. Ungarn., IV. (1886) p. 218.

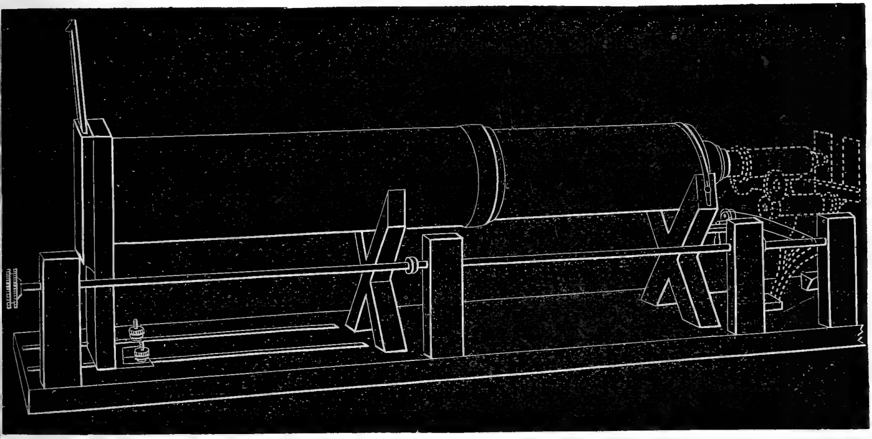
VANDERPOEL, F.—**Improved settling tube for urinary deposits.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 71–2 (4 figs.) pp. 115–6.

WARD, R. H.—**Micrometer Wires.**
[Recommends the use of platinum wires in preference to spider threads.]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 89–93.

(4) Photomicrography.

Nelson's Photomicrographic Camera.—This camera (fig. 187) was designed by Mr. E. M. Nelson in conjunction with Mr. C. L. Curties, especially for use with Prof. Abbe's new 3-power projection eye-piece. The apparatus consists first of a base-board, which is of sufficient length to take the camera when fully extended, the Microscope, and the lamp. The axis of the camera is fixed at the same height above the board as the optic

FIG. 187.



axis of the Nelson Model Microscope, but can be arranged to the height of any stand.

The camera itself consists of two cardboard tubes, which are light but strong, the one sliding into the other like the tube of a telescope; the joint between the two tubes is made light-tight by a velvet flap which is fastened down by an indiarubber band. The joint between the Microscope and camera has the usual light-excluding tubes. The camera when closed and used with the 3-power projection eye-piece is arranged to give a magni-

fication of about five times the initial magnifying power of the objective employed, and when fully extended gives ten times the initial power of the lens. The outer cardboard tube is fastened to an upright piece of wood which is clamped to the baseboard by thumb-screws at any point of its extension. The focusing screens of grey glass and plain glass with ruled lines, slide in grooves at the back of the upright piece of wood. The double back is the well-known Tylar patent metal one, which is cheap and efficient. This back is not a fourth of the cost of the wooden ones, and is free from the objectionable sticking of the slide due to the warping of the wood. The focusing is effected by a rod which runs down the right-hand side of the camera, a string passes round this and over a pulley on the other side of the board, taking a turn round the milled head of the fine-adjustment screw. This string is kept tight by a piece of elastic. The feet of the Microscope fit into blocks fastened on the baseboard.

Mr. Nelson especially recommends the aplanatic lens No. 127 in Zeiss's catalogue, power 6, as a focusing glass, and says that "the whole of the apparatus, viz. camera, Microscope, and lamp, is produced at a cost less than is usually paid for a camera alone. It is not a makeshift which is only capable of doing fairly good work, but it is proved by practical experience to be equal to the highest class of work. The Campbell differential screw fine-adjustment will be found peculiarly serviceable for photomicrographic work, as it is slow and free from spring, which is the bane of every geared-down fine-adjustment." *

Photomicrographic Camera for the Simple or Compound Microscope.† —Dr. P. Francotte's camera is intended specially for Mayer's simple Microscope, but can be used with any instrument in a vertical position. Low powers only are used. In form the camera is merely a pyramidal box with four sides. The topmost side carries a quarter-plate frame (9×12). The lower one is fitted with a brass tube by which it is arranged in the Microscope. By means of three screws, exact centering is perfectly obtained. A frame with ground glass serves for the superficial point and the regulation of light, and for the exact point a frame with transparent glass and a single lens of low power is used. The frame for the sensitized plates is double, and is supplied with two intermediate arcs, the one for a glass $6 \times 4\frac{1}{2}$ (quarter plate cut in two), the other for a quarter plate cut in four. With Steinheil's lens and monochromatic light, beautiful clichés of entire sections of larvæ of Salamander, &c., 15–18 mm. in length, were obtained. The images were 9–11 cm. long. The sections were stained with picrocarmine and the plates used were those obtained from Attout-Taillefer or those of Monckoven or Beernart sensitized for red rays by quinoline blue (cyanine).

The apparatus also gives good results with the compound Microscope, with or without the ocular.

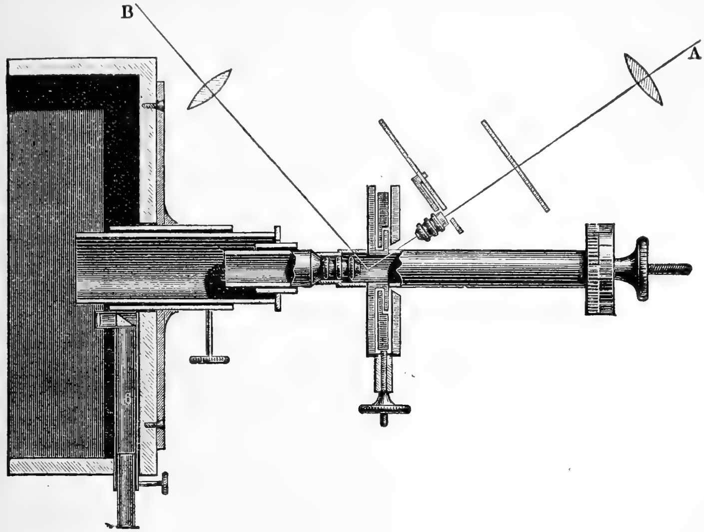
Focusing in Photomicrography.—The inconvenience of focusing by means of long rods has been attempted to be obviated in several ways. One method, by the substitution of a piece of white paper for the ground glass, viewing the image from an opening at the side, was described in this Journal, 1886, p. 841.

To accomplish the same object, Dr. B. Benecke ‡ inserted a telescope with a right-angled prism in the front part of his camera (fig. 188), by means of which the image on the screen of white paper at the other end of

* Cf. Engl. Mech., xlv. (1887) p. 213.
† Bull. Soc. Belg. Micr., xiii. (1887) pp. 149–51.
‡ 'Die Photographie als Hilfsmittel Mikroskopischer Forschung,' 1868, pp. 74–5 (1 fig.).

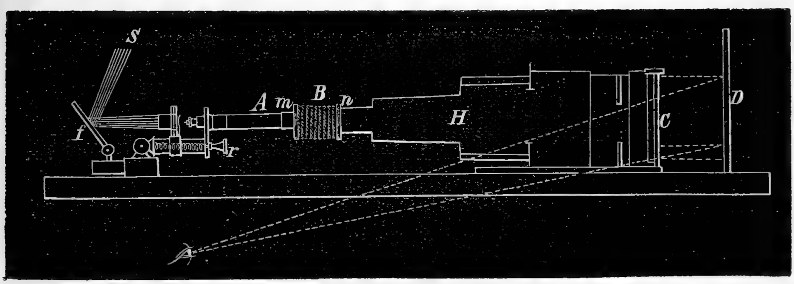
the camera was focused, the observer's head being thus in close proximity to the Microscope. (A and B are intended to show the mode of illuminating an object by oblique transmitted, and by reflected light.)

Fig. 188.



Dr. S. T. Stein* adopts the following method of focusing. The Microscope A (fig. 189) is first adjusted by direct vision until a clear image of the object is obtained; the eye-piece *m* is then removed and the body-tube united with the wooden chamber H by means of the black cloth connection B, which has rubber collars at *m* and *n*, and admits no light; the rays from the mirror *f* throw a blurred image of the object upon the ground-

Fig. 189.



glass plate of the camera C. Behind the camera is the plane mirror D, in which the observer whose eye is near the Microscope sees this image; he is thus in a position to adjust the Microscope until a well-defined image is thrown upon C by the direct use of the micrometer-screw *r* without the

* Stein, S. T., 'Das Licht,' 8vo, Halle, 1884, pp 231–2 (1 fig.). Cf. also J. Girard's 'La Chambre noire et la Microscope,' 2nd ed., 1870, pp. 52–3 (1 fig.).

intervention of any complicated mechanism such as is necessary from the usual position behind the camera. It may be convenient to examine the image with a small telescope or opera-glass.

Photomicrography with High Powers.*—Dr. O. Israel draws attention to the photomicrography of fresh objects, especially of vegetable micro-organisms in their natural condition, by the application of high powers and the use of good bromide gelatin plates.

For most microbes it is necessary to use very narrow diaphragms in order to reproduce the fineness of their lines with sufficient clearness; and as thereby much light is lost, long exposure becomes necessary. Hence also a very stable apparatus is a *sine quâ non*. The duration of the exposure is dependent on the clearness of the microscopic picture, and this in its turn depends on the source of light, the objective, and the size of diaphragm.

Diffuse daylight gives the best light, and for high powers and immersions a condenser is either desirable or necessary. Dry, water, and oil-immersion lenses are all applicable, though the best results were obtained with Hartnack's immersion ii. with correction.

It is of great importance that the object to be photographed should be very thin, in order that the parts above or below the plane in focus should not detract from the clearness of the picture.

For over-exposed pictures the author recommends the addition of a few drops of a concentrated solution of bromide of potassium to the iron developer, and this does not interfere with any subsequent treatment with cyanide of silver. Evidence of the efficacy of the method is given by the prints of negatives of micro-organisms and of other fresh objects, among which may be mentioned striated muscular fibre in salt solution.

Crookshank's 'Photography of Bacteria' and 'Manual of Bacteriology.'—The intention of Dr. E. M. Crookshank's 'Photography of Bacteria' † will be best explained in his own words:—"It might appear ill timed to publish photographs of bacteria when the apochromatic objectives, which promise to be of such great advantage in photomicrography, have just been introduced. I only wish, however, to illustrate results obtained with ordinary objectives, and to demonstrate that photography may be employed with success to represent preparations of bacteria even under conditions unfavourable for photography. There has been no desire to produce a series of feats in photomicrography; but on the other hand, I am anxious to encourage the attempt to make photography subservient to bacteriology. Those who would aim at the former should select difficult test-diatoms as their subject, and endeavour to equal or surpass the photographs taken by Dr. Woodward, of America.

"The preparations to be photographed were selected without any reference to the staining reagents which had been employed, and in some cases photographs are given which were purposely taken of bacteria so faintly stained, as to be demonstrated under the Microscope with difficulty.

"It is hoped that these photographs will be useful as supplementary illustrations to my 'Manual of Bacteriology,' while the accompanying letterpress may serve as an introduction to the methods employed in photomicrography."

A second edition of the author's 'Manual of Bacteriology' ‡ is also

* Virchow's Archiv f. Path. Anat. u. Physiol., cvi. (1886) p. 502.

† Crookshank, E. M., 'Photography of Bacteria,' xx. and 64 pp., 6 figs. and 22 plates of photographs with explanations, 8vo, London, 1887.

‡ Crookshank, E. M., 'Manual of Bacteriology,' 2nd ed., xxiv. and 439 pp., 137 figs. and 29 pls., 8vo, London, 1887.

issued, enlarged and revised, and with additional chapters on the general Morphology and Physiology of Bacteria, &c. There are seventy-three additional illustrations, and a very extensive Bibliography.

FIELD, A. G.—**A new Photomicrographic Apparatus.**
Amer. Mon. Micr. Journ., VIII. (1887) p. 94 (1 fig.).

HITCHCOCK, P.—**Resolution of pearls of Amphipleura.**
[Note on Dr. Van Heurck's photographs.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 105–6.

MAGINI, G.—**Qualche considerazioni sulla micro-fotografia.** (Some considerations on photomicrography.) *Boll. R. Accad. Med. Roma*, 1886, No. 4.

MERCER, A. C.—**Photomicrograph** *versus* **Microphotograph.**
["A photomicrograph is a macroscopic photograph of a microscopic object; a microphotograph is a microscopic photograph of a macroscopic object." The distinction was originated by Mr. George Shadbolt in 1859 or 1860.]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 131.

Microphotogrammes du Dr. Van Heurck et du Dr. P. Francotte. (Photomicrographs of Dr. Van Heurck and Dr. P. Francotte.)
[3 of *Amphipleura pellucida* resolved into beads. *Navicula fusca* and Nobert's 18th and 19th band. 4 of zoological subjects.]
Bull. Soc. Belg. Micr., XIII. (1887) pp. 159–60 (1 pl.)

Photomicrography.—See (6) American Society of Microscopists.

(5) Microscopical Optics and Manipulation.

Method of determining the index of refraction when the refracting angle is large.*—The method of minimum deviation can only be employed when the refracting angle of the prism is less than twice the limiting angle; but Signor G. Bartalini shows that indices may be measured in a prism bounded by three planes inclined to one another at two unequal angles, the ray of light being so transmitted as to be refracted at the first and third and internally reflected at the second surface. For the success of this method it is only necessary that the larger angle of the prism added to the complement of the limiting angle should be less than 180°.

The formula is

$$n = \frac{\sin a}{\sin \phi}$$

where

$$\cot \phi = \cot (\alpha - \beta) \cos^2 \theta$$

$$\sin^2 \theta = \frac{\sin b}{\sin a \, . \cos (\alpha - \beta)}$$

or

$$\cot \phi = \frac{\sin b}{\sin a \, . \sin (\alpha - \beta) \, . \cos^2 \theta^1}$$

$$\tan^2 \theta^1 = \frac{\cos (\alpha - \beta) \sin a}{\sin b}.$$

According as the ray after internal reflection makes an acute or an obtuse angle with the third surface.

In the above formulæ a and b are the angles of incidence and emergence, and α and β are the corresponding angles of the prism.

Observations made upon a quartz crystal gave—

By minimum deviation .. .. $n_o = 1 \cdot 5442$ $n_e = 1 \cdot 5537$
By the above method .. .. $n_o = 1 \cdot 5444$ $n_e = 1 \cdot 5535$.

Resolution of 200,000 lines to the inch.—Once again microscopists have been doomed to a bitter disappointment, which is the harder to bear

* Atti Soc. Toscana Sci. Nat., v. (1887) pp. 181–3 (1 fig.).

from its having been so confidently expected that at last the vapourings of microscopical theorists would be exploded and the superior value of a little practical demonstration clearly shown. Theory might attempt to decide that 200,000 lines to the inch could not be resolved with our present resources, but what could that avail against the fact not merely that 200,000 lines to an inch had been *ruled*, but that they had actually been *seen*.

When it was known that Mr. C. Fasoldt, of Albany, New York, who from all accounts is a most able and skilful ruler of lines, intended to show 200,000 lines to an inch at the last meeting of the American Society of Microscopists, expectation was at fever heat, and the feelings of some of our theoretical microscopists can be better imagined than described. It was evident that it was no longer an occasion for such merriment as followed the statement of the belief of a correspondent that "with a little patience" the feat could be accomplished, nor was the offer now only one to "make affidavits" that the lines had been seen * (as if the question was simply one of veracity), but it was declared that a practical demonstration would be given by the author of the lines in the presence of the members of one of the first microscopical societies of the world. This might well excuse, not only excitement but anxiety, on the part of those who had been pinning their faith on the fact that a good many things must happen before 200,000 lines to the inch can be not merely ruled but seen.

The day came, but alas! with the day the man came not—"circumstances prevented that pleasure." In place of the man came only a ruling and a letter. That the ruling was all it claimed to be we have no manner of doubt; what the letter was can be best appreciated by printing it in full.†

"Albany, N.Y., August 2, 1886.

"Secretary American Society Microscopists.

"Dear Sir,—I had intended to be present at your meeting this month, "but circumstances will now prevent that pleasure. With this I send the "Society a fine ruling 5000 to 200,000 lines per inch (23 bands). This "ruling has been resolved by several persons here, with my vertical "illuminator and 1/12 h. im. objective. I had intended to meet with you "and display these lines with my apparatus, but that being impossible, I "send the lines, hoping that some of the members will be able to see them "all as has been done here. I shall always be glad to receive any one "interested in rulings, and will display them to any one who will favour "me with a visit at Albany.

"Yours very truly, CHAS. FASOLDT."

The only record consequent on this letter is a vote of thanks for the gift, and we have reluctantly therefore been forced to the conclusion that there (whatever had been done "here"), no one was in fact "able to see them all," so that we have a respite, however brief, from that rude awakening which we must nevertheless consider to be still in store for us.

BOYS, C. V.—See "Orderic Vital."

EWELL, M. D.—**A further study of centimeter scale "A."**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 75–82.

" **Comparison of a standard centimeter ruled on glass by Chas. Fasoldt, with centimeter scale "A."** *Ibid.*, p. 83.

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* See this Journal, 1886, p. 868.

† Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 206.

GUNDLACH, E.—**Optical Errors and Human Mistakes.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 157–60.

HEATH, R. S.—**A Treatise on Geometrical Optics.**
[Contains sections on the Simple Microscope; Coddington lens, Stanhope lens, and Stanhoscope; Doublets of Wollaston, Pritchard, and Chevalier; sketch of theory of telescopes and Microscopes; the Compound Microscope; magnifying power of the Microscope; on the measure of the aperture of the Microscope, *post*; recent improvements in the Microscope.]
xvii. and 356 pp., figs., 8vo, Cambridge, 1887.

HIMES, C. F.—**The Stereoscope and its Applications.**
[Includes the Binocular Microscope.]
Journ. Franklin Institute, CXXIII. (1887) pp. 398–408, 425–41, 3 pls. and 13 figs.

JAMES, F. L.—
["The Neglected Twin nowhere proves his usefulness more than in microscopy. The observer who has his left hand properly trained has the purely right-handed one at an immense disadvantage. This is especially true in working with high, or comparatively high, powers. Try it, and you will see. With the left hand to manage the stage and the right upon the micrometer adjustment, one can get over a slide in less than half the time occupied when the right hand is constantly leaving the adjustment to regulate the stage."]
St. Louis Med. and Surg. Journ., LII. (1887) p. 348.

KERBER, A.—**Bestimmung der Brechungs-exponenten, für welche die chromatische Abweichung zu heben ist.** (Determination of the refractive exponents for which the chromatic aberration is to be removed.)
Central-Ztg. f. Optik u. Mech., VIII. (1887) p. 97.

" " **Ueber die Korrektur von Systemen grösserer Oeffnung.** (On the correction of systems of large aperture.) *Ibid.*, pp. 145–6.

Magnifying-power of Objectives, Measurement of.
[Inquiry by F. R. Brokenshire and replies by R. Gill, G. H. Bryan, F. J. George, and "Gamma Sigma."]
Sci.-Gossip, 1887, pp. 90–1, 116, and 163–4.
Engl. Mech., XLV. (1887) pp. 392 and 437.

"ORDERIC VITAL."—**A lens used both for refraction and reflection,** [and note by C. V. Boys.] *Engl. Mech.*, XLV. (1887) pp. 443–4 (1 fig.), 468.

POLI, A.—**[Recent progress in the Theory of the Microscope.]**
Rivista Scientifico-Industriale, April 30.
Nature, XXXVI. (1887) p. 262.

ROGERS, W. A.—**Methods of dealing with the question of temperature in the comparison of standards of length.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 67–74.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XVIII., XIX., XX., XXI.
[Diffraction, Ancient and Modern.]
Engl. Mech., XLV. (1887) pp. 331–2 (5 figs.), 379 (1 fig.), 427 (4 figs.), 475–6 (6 figs.).

STOKES, A. C.—**Focus Upward.**
["It has been said in a joking way 'that nothing will throw a microscopist into a chill quicker than to see a friend look into his Microscope and focus downward with his coarse-adjustment.' Yet men who ought to know better have been seen to do this reprehensible thing."]
Queen's Micr. Bulletin, IV. (1887) p. 23, from 'Microscopy for Beginners.'

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of Lens-systems.) (Sep. Repr.) 16 pp., 8vo, Tübingen, 1887.

(6) Miscellaneous.

Microscopical Society of Calcutta.—A Microscopical Society has, on the suggestion of Mr. W. J. Simmons, been founded at Calcutta,* with an entrance fee and annual subscription of five rupees. It is intended to have two Sessions, one in the cold season and the other in the middle of the year, with a recess after each. Meetings will be held monthly. So far as we know, this is the only Microscopical Society in any part of India. There must be a large and very interesting field for microscopical work in that part of the world, and we wish the new Society every success.

* Indian Daily News, 1887, June 25.

American Society of Microscopists.—The Working Sessions.
[1. The dredging excursion. 2. Photography (discussion and demonstration of photography by lamplight in its application to the Microscope). 3. The General Session (various exhibitions and practical demonstrations).]
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 174–96.

" " " **Reports of Committees on Micrometry and on Universal Microscope Screw.** *Ibid.*, pp. 197–8, 199–201.

BURRILL, T. J.—**Presidential Address.**
[Bacteria and disease.] *Proc. Amer. Soc. Micr.*, 9th Ann. Meeting, 1886, pp. 5–29.

Dallinger's (Rev. Dr.) Presidential Address.
["Professor Dallinger presents a far more commendable course, as shown in his laborious and conscientious work described in his presidential address before the Royal Microscopical Society. Instead of predetermining that an organism cannot adjust itself to changed environment, because it might follow that species could be evolved from each other, a conclusion at variance with our narrow notion of the way in which an Infinite Creator would proceed in peopling a world with animals and plants, he goes about a series of most delicate experiments, lasting through seven years without a break, to learn if it is a fact that environing conditions may be greatly changed and yet the organism adjust itself to the change. No one can read his account without admiration for such painstaking and intelligent experimentation and for the determination, after the break in the series, to go over the ground again. Such work done by the leaders inspires the rank and file of workers, and it is such work as this which has given us scientific discoveries and their benefits."]
Amer. Mon. Micr. Journ., VIII. (1887) p. 114.

FINK, H. E.—**"The Eleventh Commandment in the eye of a needle."** (Exhibition.)
The Microscope, VII. (1887) pp. 143–4.

GILMER, T. L.—**The Microscope in Dentistry.** *Dental Review*, 1887, May.

JEAFFRESON, C. S.—**Presidential Address to the North of England Microscopical Society.** Eighth Ann. Rep., 27 pp., 8vo, Newcastle-upon-Tyne, 1887.

[MANTON, W. P., AND OTHERS.]—**Making a Microscopist.**
The Microscope, VII. (1887) pp. 176–8.

MICHAEL, A. D.—**Presidential Address to the Quekett Microscopical Club.**
[Darwinism.] *Journ. Quek. Micr. Club*, III. (1887) pp. 44–62.

Microscopist, an enthusiastic.
[Note on Mr. E. H. Griffith.] *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 114.

Moore, A. Y., Death of.
[Memorial resolutions of the Cleveland Microscopical Society.]
Amer. Mon. Micr. Journ., VIII. (1887) p. 97.

" " **Obituary notice of.**
The Microscope, VII. (1887) pp. 137–40 (portrait) and p. 149.

Noble, Captain, and this Journal.
[Comment by Editor on note, *ante*, p. 494.] *Eng. Mech.*, XLV. (1887) p. 402.

Pharmacy, the Microscope in.
["The Pharmaceutical Society of Brooklyn, in its lectures to drug clerks, includes a course on the Microscope in Pharmacy."]
The Microscope, VII. (1887) p. 125.

PUMPHREY, W.—**The Microscope in the Lecture- and Class-room.**
[Concludes that when the object is to demonstrate to a class, or to a small company, who can critically examine the image as displayed on the screen, the image, as taken direct from the object, is much to be preferred; but that for large companies, and where the close examination of the image would be impracticable, the photomicrograph is better adapted to the purpose.]
Journ. of Microscopy, VI. (1887) pp. 141–7.

SORBY, H. C.—**The Microscopical Structure of Iron and Steel.**
[Paper laid before the Iron and Steel Institute, May 1887.]
The Ironmonger, 1887, June 4, pp. 391–9.

STRASBURGER, E.—**Das botanische Practicum.** (Practical Botany.)
2nd ed., xxxvi. and 685 pp., 193 figs., 8vo, Jena, 1887.

WARD, R. H.—**Remarks on the methods of making Microscopical Societies successful.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 94–102.

WEST, C. E.—**Forty years' acquaintance with the Microscope and Microscopists.**
Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 161–73.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Blood-serum Cultivation.†—Dr. F. Hueppe combines the advantages of blood-serum for growing micro-organisms with the advantages of plate cultivation for separating the colonies in the following manner:—Blood-serum is sterilized at a temperature of 58°–60° by the discontinuous method. It may, however, be sterilized at once and with safety by heating to boiling-point, but although its nutritive properties are apparently unaffected, it loses slightly in transparency. The author gives an illustration of a modification of Fol's sterilizer, heated by the same arrangement as the author's own thermostat.‡ The tubes are laid in the oblique position. After sterilization the serum is warmed to 37° C. and inoculated in the usual manner.

Meanwhile, a 2 per cent. agar solution, to which 0·5–1 per cent. grape sugar is added, has been prepared. Having been fluidified, the agar is cooled down to 42°–45°. Equal quantities of the warm inoculated blood-serum and of the warm agar solution are then mixed together, with the usual precautions, and having been well shaken up, are allowed to solidify in plates, bulbs, &c., at the ordinary temperature. When firm the cultivations are removed to the thermostat. By this method the breeding of tubercle-bacilli from sputum succeeds pretty well.

CROSIER, R.—**A method of inoculating fluid cultivating media.** *Brit. Med. Journ.*, 1886, No. 1347, p. 769.

EDINGTON, A.—**A new culture medium for micro-organisms capable of withstanding high pressure.** *Lancet*, 1886, II. p. 704.

GRIESSMAYER.—**Die Reinkultur der Microben mit specieller Rücksicht auf die Hefe.** (The pure culture of microbes with special reference to yeast.) *Allg. Brauer- und Hopfen Ztg.*, 1887, pp. 591–2, 603–5.

KOLESSNIKOW.—See Tarchanow.

MACÉ.—**Sur la préparation des milieux à la gélose pour la culture des bactéries.** (On the preparation of gelatin media for the cultivation of bacteria.) *Ann. Instit. Pasteur*, 1887, pp. 189–90.

SMITH, T.—**The relative value of cultures in liquid and solid media in the diagnosis of bacteria.** *Med. News*, 1886, II. p. 571.

STERNBERG, G. M.—**Bacteriological Notes. The liquefaction of gelatin by bacteria.** *Med. News*, 1887, pp. 372–3.

TARCHANOW and KOLESSNIKOW.—**Die Anwendung des alkalisch gemachten Eiweisses von Hühnereiern als durchsichtiges Substrat zur Kultur der Bacterien.** (The use of alkaline albumen of hens' eggs as a transparent substratum for the culture of bacteria.) *Russkaja Medicina*, 1887, No. 11 (Russian).

TERRY, W. A.—**Notes on Diatom study.** [Dredging for diatoms.] *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 44–6.

VIGNAL, W.—**Étuve pour Cultures.** (Culture oven.) *Ann. Instit. Pasteur*, 1887, pp. 184–8.

(2) Preparing Objects.

Method for subjecting Living Protoplasm to the action of different liquids.§—Mr. G. L. Goodall, for studying the action of very dilute solutions on living protoplasm, obviates the necessity of transferring the specimen from the litre-flask, as in the methods of Loew, Bokorny, and Pfeffer, to the stage of the Microscope, by using an apparatus consisting

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Centralbl. f. Bacteriol. u. Parasitenk, i. (1887) pp. 607–10 (1 fig.).

‡ Med. Wochenschr., 1886, No. 17.

§ Amer. Journ. Sci., xxxiii. (1887) pp. 144–5.

of a small number of "chloride of calcium jars," i.e. tall slender jars with an opening near the base, which are connected by means of "three-way" tubes with a common tube of small size. The latter tube is inserted into the side of a microscopic cell made of soft rubber, firmly cemented to the slide and provided with an inflow and an outflow. The object is held beneath the glass cover either by delicate glass floats or by glass threads fastened by wax. When the object is *in situ* the liquid is made to flow by opening one of the cocks or one of the way tubes. The stream of fluid may be made slow or rapid, and one fluid may be substituted for another.

The same apparatus may be used for differential staining, for plasmolytic investigation, and for the cultivation of organisms under different conditions of nutriment.

Modes of preparing Ova.*—Dr. H. Henking, in his investigations into the development of the Phalangida, adopted various methods of preparing the ova; the animals were sometimes killed with boiling water, and left in it for some time for the albumen to coagulate; they were then hardened in successive strengths of alcohol up to 80 per cent. The ova were never placed direct in alcohol, in consequence of the shrinking caused by such a process. Other specimens were killed with ether, the back laid open, and the animals placed in Flemming's chrom-osmic-acetic acid, or in Kleinenberg's picrosulphuric acid for some hours before removal to alcohol. Eggs that had been deposited were treated with hot water, and with Flemming's fluid, as well as with hot and cold chromic acid, picrosulphuric acid, &c. The best staining reagents were found to be Grenacher's borax-carmine, Hamann's neutral acetic acid carmine, and eosin-hæmatoxylin. Before imbedding, the eggs on being taken from absolute alcohol were placed in a mixture of bergamot oil and absolute alcohol, then in pure bergamot oil, and then in a warmed solution of paraffin in bergamot oil, and finally in quite pure paraffin. By the aid of Spengel's microtome sections from 1/80 to 1/150 mm. thick were prepared.

New Method of distinguishing Vegetable from Animal Fibre.†—Dr. H. Molisch's process depends on the application of the two new reactions for sugar lately discovered by the author:‡—About 0·01 gram of the sample, previously well boiled and washed with water, is mixed first with 1 ccm. of water, then with two drops of an alcoholic solution of a-naphthol (15–20 per cent.), and finally with an equal volume of concentrated sulphuric acid. In the case of vegetable fibre the solution assumes, immediately after shaking, a deep violet colour, the fibre being dissolved. If, however, the fibre is of animal origin, the liquid assumes a colour varying from yellow to reddish-brown. By substituting a solution of thymol for a-naphthol a fine carmine colour is obtained in the place of the violet.

The author has successfully applied this test to different vegetable fibres, such as cotton, hemp, jute, china-grass, &c.; also to the cellular tissues of wood, cork, and fungi. Moreover, in the case of dyed fabrics the colouring matters do not appear to interfere with the success of the reaction.

Mode of examining Mucous Membranes.§—Prof. L. Ranvier describes the following method of studying the membrane which invests the retrolingual sac of the edible or the grass-frog. The membrane is detached and then extended on the disc of Ranvier's moist chamber in such a

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 88–90.

† Dingler's Polytech. Journ., cclxi. (1886) pp. 135–8. Cf. Journ. Chem. Soc. Lond., Abstr., 1886, p. 1088.

‡ See this Journal, *ante*, p. 344.

§ Comptes Rendus, civ. (1887) pp. 819–20 (1 fig.).

way that its epithelial surface is turned upwards. During this operation desiccation of the tissues is avoided by sprinkling them with aqueous humour, blood-serum, or chloride of sodium in 7/1000 solution; the membrane is maintained in a state of extension by a ring of platinum which is fixed on the disc of the moist chamber; the ring must be of a little longer diameter than that of the disc, in order that the membrane may be held between it and the disc. The membrane is covered by a glass plate, which is fixed with paraffin. In such a preparation the cells with vibratile cilia, sensory or glandular cells, striated muscular fibres, and nerve-fibres and cells may be easily observed in the living state. As the ring keeps the membrane in its place, the glass cover may be removed for the purpose of adding reagents.

Investigating the Termination of Nerves in the Liver.*—Mr. A. B. Macallum adopted the following method for demonstrating nerve-structures in the liver of *Necturus* (= *Menobranchus*). Pieces of the liver were hardened for a week or more in Erlicki's fluid, or for several days in a 1/6–1/5 per cent. solution of chromic acid. After the hardening was sufficiently completed in alcohol, sections of the frozen tissue were made with a Cathcart microtome. When the gum was carefully removed these were put in a 5 per cent. solution of formic acid for an hour, transferred to a 1 per cent. solution of gold chloride for about twenty minutes, then washed in distilled water, and the gold afterwards reduced in the dark with a 10 per cent. solution of formic acid. About thirty hours suffices for this reduction at a temperature of 20° C., and the sections then have a deep red colour, though the tinge was sometimes violet. The chromatin of the nuclei of the hepatic cells took a deep blue-violet tint, the caryoplasm light violet, while the cytoplasm came out very distinctly as a meshwork with a pink or light carmine colour; the nerve-fibres appeared deep violet, but the connective tissue of the interlobular spaces attained a light, or sometimes a deep red colour. When chromic acid was used as a hardening reagent the addition of any organic acid at the same time, such as acetic acid more especially, seemed to have the effect of robbing the nerve-fibres of their selective capacity for gold. Sections of the liver of *Necturus* are of no value when they are less than 0·02 "m" [mm.] in thickness. With the human liver preparations proved to vary very considerably, but were often not successful.

All the sections were cleared in oil of cloves and mounted in balsam. The study of the ultimate terminations of the nerves was made with the Leitz 1/12 in. homogeneous immersion, with special illumination.

The author discusses the value of gold chloride as a reagent for differentiating nerves, which is not admitted by all histologists; he thinks that it has many advantages over other reagents; the substance which fixes the gold in a violet form is not confined to nerves, but appears to be diffused to a small degree in other tissue elements; the failures of some histologists are referred to their not having sufficiently hardened the tissues. Osmic acid, although useful in the case of medullated nerve-fibres, is of no value for demonstrating the finest non-medullated fibrils.

Preparing the Amphibian Egg.†—Prof. O. Schultze has found that for hardening-fluids the following mixtures give perfectly satisfactory preparations when used in the manner described below:—(1) *Chromo-osmio-acetic Acid:* Chromic acid (1 per cent.) 25 parts; osmic acid (1 per cent.)

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 443–8.

† Zeitschr. f. Wiss. Zool., xlv. (1887) p. 185. Cf. Amer. Naturalist, xxii. (1887) pp. 595–6.

10 parts; water 60 parts; acetic acid (2 per cent.) 5 parts. (2) *Chrom-acetic Acid:* Chromic acid (1 per cent.) 25 parts; acetic acid (2 per cent.) 5 parts; water 70 parts.

The eggs are left in one of these fluids twenty-four hours, then washed in distilled water, which should be often changed. The egg-envelopes are next removed by the aid of needles, and the eggs are then ready for surface-study.

For the purpose of sectioning the eggs are transferred from the water used in washing to 50 per cent. alcohol, then to 70 per cent., 85 per cent., and 95 per cent., leaving them twenty-four hours in each grade. The last grade should be changed several times. The eggs are then clarified in turpentine one to two hours, and then placed in paraffin that melts at 50° C. from one-half to one hour.

Prof. Schultze states that the success of the method depends on following precisely the directions given as to time. If the eggs remain longer, either in alcohol, turpentine, or paraffin, the results may be entirely unsatisfactory. If the conditions are strictly followed the eggs have the consistency of the paraffin, and cut excellently without crumbling in sections 1/200 mm. thick.

For staining, borax-carmine was used, directly after washing, twenty-four hours. The eggs were next placed in acid alcohol of 70 per cent. (five drops of the pure acid to 100 ccm. of the alcohol) to remove a part of the colour.

The first hardening fluid does not penetrate well, and is not well adapted for fixing the central parts of the egg.

Preparing Eyes of Molluscs and Arthropods.*—Mr. W. Patten's methods for preparing the eyes of Molluscs and Arthropods are as follows:—

I. MOLLUSCS (preparation of young *Pectens* from 1–3 mm. long).—(1) Specimens are placed in a mixture of equal parts of sublimate and picrosulphuric acid. After ten or fifteen minutes they are washed in 25 per cent. and 70 per cent. of alcohol.

(2) The shells are then opened, and the mantles dissected out with needles. Thus treated, the shape of the mantle is well preserved, whereas if removed before hardening it becomes much coiled and twisted.

(3) Each mantle edge may be cut, according to its size and curvature, into three or four pieces, and these will then lie sufficiently straight for convenient sectioning.

It is necessary to use a different reagent for nearly every part of the eye.

The Rods.—Chromic acid gives the most varied results according to the strength, time of action, and temperature of the solution, or by various combinations of these three. For instance, 1/20 to 1/5 per cent. for thirty to forty hours failed to give any conception of the structure of the rods, while other parts of the retina, and of the eye itself, were well preserved; but when allowed to act for half an hour at a temperature of from 50° to 55° C., perfectly preserved rods with their nervous networks are obtained, whilst, on the other hand, the remaining tissues become so granular and homogeneous as to be unfit for study. This treatment allows the rods to be removed in flakes, and their ends examined without the aid of sections. It is only in this way that the axial nerve-loops can be observed.

* MT. Zool. Stat. Neapel, vi. (1886) pp. 733–8. Cf. Amer. Natural., xxi. (1887) pp. 401–4, and this Journal, *ante*, pp. 53 and 82.

The Lens.—The lens is best prepared for sections by either sulphuric or picro-sulphuric acid; by the first reagent its shape is best retained, and the lens itself is less liable to be drawn away from the surrounding tissue; the latter reagent, however, brings out more sharply the configuration of the cells, and allows a better stain of the nuclei to take place.

The Retinophoræ.—The retinophoræ are well preserved by nearly all the reagents; but in sublimate, in picric acid, or in their combinations, they become slightly granular, and remain so closely packed that it is difficult to distinguish the cell boundaries. Chromic acid 1/5 per cent. for three or four days, contracts the cells and gives preparations in which the boundaries and general arrangement of the retinophoræ are easily studied.

Section of the Eye.—In order to obtain the best sections of the adult eye with *all* the parts in the most natural position, it is necessary to treat them first with 1/10 per cent. of chromic acid for half an hour, then in 1/20 per cent. for twenty-four hours; 1/10 per cent. for twenty-four hours, and finally 1/5 per cent. for forty-eight hours or more. Next to this method, it appears that solutions of sulphuric acid (twenty drops to fifty grammes of water) give the best preparations (for sectioning) of everything except the rods.

The double layer of the sclerotica and the fibres penetrating it can be seen in sections of eyes treated twenty-four hours in 1/5 per cent. chromic acid.

Maceration and Dissection.—The *pigmented epithelial cells* of *Pectens'* eyes and the cells of the *cornea* are easily isolated by treatment with Müller's fluid or bichromate of potash 1/2 per cent. for two or three days. For the maceration of all other elements weak chromic or sulphuric acid is used. For the outer ganglionic cells, which are very difficult to isolate, maceration in 1/50 per cent. chromic acid gives excellent results, after previously fixing the tissue in 1/5 per cent. for a few minutes.

For the *retinophoræ*, 1/20 per cent. for four or five days proves very useful.

Sulphuric acid 5 drops to 30 grammes of sea-water gives the best results for the nerve-endings in the retinophoræ (not in the rods), and for the nervous inner prolongation of the outer ganglionic cells.

In order to isolate pieces of the cornea with the subjacent *pseudocornea* and the circular fibres on the outer surface of the lens, it is better to macerate the eyes in sulphuric acid as given above. The same treatment retains to perfection the natural shape of the lens, which may then be isolated, and its surface studied to advantage.

It is necessary for the study of the *circular retinal membrane*, the *septum*, and the *retina* itself, to isolate the latter intact. Maceration in chromic acid either makes the retina too brittle or too soft, while the axial nerve-fibres remain so firmly attached to the retina that it is difficult to isolate it without injury. But this may be easily and successfully done by maceration for one or two days in the sulphuric acid solution. By this treatment the *retina*, together with the *septum* and *circular retinal membrane*, may be detached entire.

Surface views of the retina show the peripheral outer ganglionic cells. The *argentea* may be very easily separated in large sheets by macerating for four or five days in bichromate of potash of 1 per cent.

Sulphuric acid is a most valuable macerating as well as *preservative reagent.* In weak solutions (40 drops to 50 grammes) entire molluscs, without the shell, have been kept in a perfect state of preservation for more than six months. For cilia and nerve-endings it is exceptionally good.

The eyes of *Arca* and *Pectunculus* may be macerated either in Müller's

fluid or chromic acid. Undiluted Müller's fluid in twenty-four hours gives more satisfactory preparations than a weak solution which is allowed to act for a longer period. Chromic acid 1/5 per cent. for ten or twelve days gave most of the preparations from which the drawings of the nerve-endings in the author's paper were made. A few drops of acetic and osmic acid added to distilled water gave a very energetic macerating fluid for the epithelium of marine molluscs. Such preparations led to the discovery of the very delicate outward continuations of the pigmented cover-cells in the compound eyes of *Arca*.

II. Arthropods.—In order to demonstrate the presence of the *corneal hypodermis* in the facetted Arthropod eye, and the connection of the so-called "rhabdom" with the crystalline cone cells, it is necessary to resort to maceration. In most cases it is hardly possible to determine the important points by means of sections alone.

The ommateum of fresh eyes, treated for twenty-four hours or more with weak sulphuric or chromic acid, or in Müller's fluid, may be easily removed, leaving the corneal facets with the underlying hypodermis uninjured. Surface views of the cornea prepared in this way show the number and arrangement of the corneal cells on each facet. In macerating the cells of the ommateum it is not possible to give any definite directions, for the results vary greatly with different eyes, and it is also necessary to modify the treatment according to the special point to be determined. It is as essential to isolate the individual cells as it is to study cross and longitudinal sections of the pigmented eyes. In determining the number and arrangement of the cells and the distribution of the pigment, the latter method is indispensable; it should not be replaced by the study of depigmented sections, which should be resorted to in special cases only.

In *fixing* the tissues of the eye, it is not sufficient to place the detached head in the hardening fluid; antennæ and mouth-parts should be cut off as close to the eye as possible, in order to allow free and *immediate* access of the fluids to the eye. When it is possible to do so with safety, the head should be cut open, and all unnecessary tissue and hard parts removed. With abundant material, one often finds individuals in which it is possible to separate, uninjured, the *hardened* tissues of the eye from the cuticula. This is of course a great advantage in cutting sections. The presence of a hard cuticula is often a serious difficulty in sectioning the eyes of Arthropods. This difficulty can be diminished somewhat by the use of the hardest paraffin, and by placing the broad surface of the cuticula at right angles to the edge of the knife when sectioning. Ribbon sections cannot be made with very hard paraffin, but it is often necessary to sacrifice this advantage in order to obtain very good sections.

Killing Polyzoa.*—Mr. T. Whitelegge writes:—"I place a small twig of Polyzoa in about two or three drachms of water; when fully expanded I add about two drops of chloroform, and these should be dropped in so that they sink to the bottom. In from a quarter to half an hour I add spirits, about six drops at a time, and stir up gently, so that it gets mixed with the water. The spirits and chloroform stupefy them, and I try touching one to see if they are in a sleepy condition; then I add more spirits gradually, mixing it and the water each time. When the fluid consists of equal quantities of water and spirit, I let them stand for a time, then add spirit very cautiously till they are in nearly pure spirit. This is necessary, as they contract, even after death, if the water is extracted from them too rapidly. When they are killed they should on no account

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 30-1.

be *lifted* out of the vessel, but floated from one vessel to another. If they are lifted out the tentacles become disarranged, and cannot again be put right."

Preparation of Insect Spiracles.*—Mr. F. Dienelt remarks that in most beetles the spiracles are found on the upper part of the abdomen. The insect should be turned on its back and cut across the thorax close to the abdomen; then turn again, and insert a sharp knife into the opening made, and cut round the whole abdomen. As soon as there is room, insert a small stick of soft wood sharpened to a flat point, by means of which the object can be held securely while cutting. All the cutting should be done on the lower side, so that a margin is left on the upper part, which can be trimmed easily after the object has become softened in liquor potassæ. Steeping the insect in this fluid for a couple of hours will destroy all the viscera. Now, hold the part down with the pointed stick, which for this purpose is far superior to mounting-needles, and with a camel-hair pencil remove the viscera and transfer the object to rain-water, removing this two or three times to insure cleansing and to remove the last trace of potash. Keep on brushing until it is certain that the object is clean, and then trim the edges to suit before a final washing. If it be desired to mount the tracheæ *in situ*, greater care is necessary in treating, but they show very well through the skin. Or after most of the viscera have been removed, the tracheæ can be torn by a sawing motion with the back of the knife from the spiracles and mounted separate. In mounting larvæ entire, they should be left in liquor potassæ for a longer time; even a whole day without injury. In cleaning, it is necessary to keep them in the position in which they are to be mounted. Larvæ of the Lepidoptera show best when mounted on the side. In preparing these, hold the larva under water with the pointed stick, and clear out the viscera with a brush through the anal opening by a rolling motion. After a start has been made the process takes but a short time. Larvæ will stand considerable pressure in cleaning, but gentle manipulation of course answers best, especially in those covered with hair. It is best to commence with the largest beetles or larvæ one can find. Larvæ too large to be mounted entire ought to be opened along the back to give the liquor free access.

Twenty-seven grains of potassa fusa to one ounce of water acts but slowly on the chitinous parts of insects, but very promptly on the viscera. It is best kept in a paper-covered bottle, to exclude the light.

Botanical Manipulation.†—M. P. Girod's 'Manipulations de Botanique' treats, in the first place, of the methods of using the Microscope, reagents, &c. The rest of the work consists of a series of original diagrams illustrative of the histology and anatomy of typical plants, from Dicotyledones to Algæ, ending with cell-tissue for purpose of comparison with unicellular organisms. Short notes explaining the methods of preparing sections accompany the plates.

Preparation of Plants in Alcohol.‡—M. H. de Vries explains the great brittleness imparted to fresh parts of plants by plunging them in alcohol in the following way:—The alcohol penetrates first into the outer, and only gradually into the inner, layers of tissue. While the outer cells are killed, the inner cells still retain all their turgidity. These inner still living cells prevent the contraction of the cell-walls in the outer layers, and the latter become, therefore, hardened while still in the stretched condition. While

* The Microscope, vii. (1887) pp. 102–3.
† Girod, P., 'Manipulations de Botanique,' 72 pp. and 22 pls., 8vo, Paris, 1887.
‡ Maandbl. v. Natuurwetensch., 1886. See Bot. Ztg., xlv. (1887) p. 31.

this process is advancing from without inwards, the inner cells also die, and the contraction of their walls is prevented by their connection with the outer layers which have already become stiff; and they also become hard while in the stretched condition. The brittle tissues can be softened by soaking in water for from half an hour to an hour, and do not then again become brittle if again placed in strong alcohol.

Cleaning Diatoms.*—Mr. W. A. Terry recommends the following process for cleaning diatoms. No fumes of any consequence are given off, no artificial heat is required, the process takes only a few minutes, and a much larger proportion of the diatoms are uninjured:—

After washing out the coarse sand and straining out the coarse refuse from the gathering which has not been dried, the material is allowed to settle in the vessel; the water is then poured off rather closely, so that the amount remaining shall be about equal in weight to the weight of the material dry. Finely powdered bichromate of potash is then added in amount equal to the estimated amount of organic matter in the material exclusive of the sand. It is then stirred until mixed; for this purpose a glass slip half an inch wide, with rounded edges, is more convenient than a glass rod. Strong commercial sulphuric acid is then dropped in until brisk effervescence is set up, and continued until the acid produces no effect. The whole mixture is then poured into a vessel containing cold water, and after agitation is allowed to settle. The diatoms will now be found to be nearly clean, and only require the usual alkaline treatment and thorough washing. After the addition of the bichromate, the temperature of the material and of the acid should not be less than 70° F. If the diatoms be not sufficiently cleaned, the operation may be repeated or nitric acid used without much danger. If the material have been dried, it will be well to soak or boil it in water before using acid. Marine muds should be first washed in fresh water to remove the salt, and as they contain more refractory material, the action should be proportionately energetic. Fossil marine earths should be thoroughly softened by long soaking and boiling before being treated with acids, otherwise the gases disengaged would tear and fracture very many of the forms. Boiling in alkalies should be avoided, if possible, as many varieties are softened and distorted by even cold and weak solutions. As first washings, both acid and alkaline, settle very slowly, they should be allowed plenty of time, otherwise the lighter and more delicate varieties would be lost.

The author states that he usually succeeds in getting the diatoms beautifully white and clean at the first operation, but admits that the process is capable of some improvement.

Preparing Silver Crystals.†—Mr. F. T. Chapman says that artificially prepared silver crystals make fine opaque objects, either as permanent mounts, or for observing the process of crystallization. They may be readily prepared, although some care is necessary in order to obtain the best results, especially if the preparation is designed to be permanent.

The deposition of silver from a solution of silver nitrate by means of copper, preferably a copper-wire ring placed in a sufficiently deep cement cell, gives very good results if the wire ring and the thicker mass of crystals at the edge be removed, and the specimen then thoroughly dried and protected by a cover-glass in the usual way. Much better results, however, can be obtained with a brass cell provided with a removable cover or cap (known as the "Pierce cell"), and cemented to a glass slip, the cell being

* Amer. Mon. Micr. Journ., viii. (1887) pp. 69–71. † Ibid., pp. 99–100.

backed by dark-coloured wax. When filled with the solution, the deposition of silver crystals on the inner surface of the cell will immediately commence and proceed slowly toward, but should not be permitted to reach, the centre. When the crystals have approached so near the centre as to leave a clear space of about 1/8 in. in diameter, the solution should be removed by means of a small piece of blotting-paper placed on top of the cell and allowed to remain for a moment. The strength of the solution is not important, but should not be very weak, as the feathery masses of crystals that add greatly to the beauty and depth of the mount do not then appear.

If the crystals, when forming, appear white and brilliant, or darken slightly, or appear to be very fine or small at the sides of the cells, while those at the bottom are spray-like and quite large, the result will usually be successful, although the best conditions are when the bottom of the cell is occupied by several large feathery sprays of crystals, and the sides by shorter sprays or spine-like crystals, the whole being white and brilliant. Sometimes, after the solution has been removed, a deposition of copper on the silver will be found, or crystals of copper salts will intermingle with the silver, and mar its appearance, in which case it is necessary to reprepare the mount. If the silver be permitted to reach the centre, a black precipitate will form and spoil the preparation as a permanent mount, but as the fluid is then filled with a mass of minute sparkling crystals in constant motion, the effect is both interesting and beautiful when viewed with a power of about twenty-five or fifty diameters.

The time usually occupied in preparing a silver mount is about five minutes, the preparation being completed when the solution is removed from the cell by the blotting-paper.

If the crystallization of the silver be unsatisfactory, the cell may be readily cleaned and another layer of wax applied. In order to apply the wax to the cell, a sheet is placed on the cell, pressed slightly with the finger, and a disc of wax forced into the cell by means of a cork that will snugly fit it, sufficient pressure being applied to cause the wax to adhere to the glass slide or to the wax already in the cell.

There seems to be no rule by which the deposition of the crystals can be regulated, as under apparently the same conditions one preparation will be successful and the next one will be a failure. It would seem that a small quantity of gum in the solution would cause the crystals to adhere, and prevent them from breaking or shaking loose when the slide is handled roughly. Gum arabic has been tried without success, as it causes the crystals to turn black. However, the crystals usually adhere firmly enough to the cell and to each other to stand all ordinary usage. A greater mass of crystals may be obtained by repeating the deposition in the same cell, and allowing one mass of crystals to form on the top of the other. When forming in the solution, the crystals seem to almost completely fill the cell, standing out laterally, but when the fluid is removed they fall to the bottom and appear to the eye to form a thin layer, but under the Microscope they stand out in bold relief.

Preparing Crystals of Silicon Fluoride.*—Beautiful objects for polarized light are produced by the action of undiluted fluoric acid on an ordinary glass slide, the results varying with the composition of the glass acted upon. The best results are to be obtained by using slips of thin polished plate and the following process:—Cut a circular hole in a piece of sheet modelling wax; warm the slide slightly, and make the wax adhere

* Scientif. Enquirer, ii. (1887) pp. 128–9, from 'Dental Record.'

well to it, so as to form a fluid-tight cell. Into this put four or five drops of the acid; watch its action closely when the glass has acquired an opaque film, which will be in from three to five minutes; wash it with a stream of warm water; finish with a camel-hair pencil. Remove the wax and dry the slide. The result shows crystals of silicon fluoride, which require no mounting.

Blood, permanent Preparations of.
[Method taught in Heidelberg.] *The Microscope*, VII. (1887) p. 115.

BRAMWELL, R.—**Process for the detection of micro-organisms in nerve-tissue.** *Edin. Med. Journ.*, 1886, p. 324.

CASTELLARNAU, J. M. DE.—**Procédés pour l'Examen microscopique et la Conservation des Animaux à la Station zoologique de Naples.** (Methods for the microscopical examination and the preservation of animals at the Naples Zoological Station.) *Journ. de Microgr.*, XI. (1887) pp. 183–6, 215–7, 447–53.

FELLOWS, C. S.—**Collecting, dissecting, and mounting Entomostraca.** *Proc. Amer. Soc. Micr.*, 9th Ann. Meeting, 1886, pp. 186–8.

MARTIN, L. J.—**Petroleum Spirit as a Plant Preservative.**
[Recommends petroleum spirit (boiling from 25°–45° C.) for preserving plants intended for the study of chemical constituents.] *Bot. Gazette*, XII. (1887) p. 42.

MILES, J. W. L.—**The capturing, killing, and preservation of Insects for microscopical purposes.** *Trans. and Ann. Rep. Manchester Micr. Soc.*, 1886, pp. 80–1.

PARKES, R.—**The preparation of Foraminifera from common chalk.** *Trans. and Ann. Rep. Manchester Micr. Soc.*, 1886, p. 21.

(3) Cutting, including Imbedding and Microtomes.

Ryder's Paraffin Imbedding Apparatus.*—Prof. J. A. Ryder describes a new paraffin imbedding apparatus which he has designed.

Those who have had much experience in imbedding in paraffin are aware of the difficulties and risks which attend the imbedding of delicate objects on account of the danger of overheating the imbedding mass. The trouble with thermostats, or heat-regulators, is that they get out of order and give trouble, apart from the difficulty which arises from the variations in the pressure of the gas in the pipes which supply the burners, and which is entirely beyond the control of most forms of the thermostat. To avoid this, Dr. C. S. Dolley, of the Biological Department of the University of Pennsylvania, began a series of experiments with copper bars, which were heated at one end by means of a Bunsen burner, so that the heat conveyed by conduction to the remote end of the bars gradually diminished in intensity, because of its being constantly radiated into the surrounding air, according to well-known laws stated in the text-books on physics. It was found that, with the room at an approximately constant temperature, there was a point along the bar, at a certain constant distance from its heated end, where the temperature of 55° C. could be maintained, and where, if there was placed a copper cup filled with hard paraffin, the latter could be kept just at the point of fusion for a long time without endangering the objects to be imbedded. These results showed that it was possible to utilize an apparatus of this type for imbedding purposes.

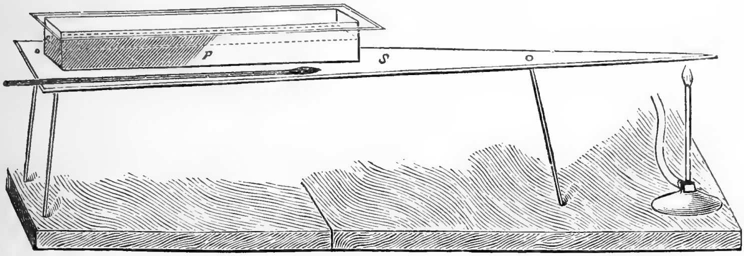
This led the writer to begin a set of experiments with a very simple modification of the foregoing type of apparatus, with the object of getting rid of the usual water-bath entirely in the process of imbedding, and to also use the paraffin itself as a means to indicate how far away from the source of heat it would be safe to allow an object to remain while it was being saturated.

The object was effected in the following manner:—A triangular sheet

* Amer. Naturalist, xxi. (1887) pp. 597–600 (1 fig.).

of copper, slightly less than 1/16 in. thick, 18 in. long, and 10 in. wide at one end and running to a sharp point at the other, as shown at *s* in fig. 190, is supported horizontally upon two legs at the wide end, and at some distance from the pointed end by another leg, these three legs constituting a firm tripod base for the whole device. Under the pointed end of the triangular plate of copper is placed a small Bunsen gas-burner, with an aperture of about 1/8 in., and connected with the gas-supply of the building by means of a rubber tube. If the flame is allowed to burn

FIG. 190.



steadily at about half its full force, and permitted to play upon the copper plate at a distance of about 1 in. from its extreme point, as shown in the figure, the whole plate will soon be heated, but the temperature will be found to gradually diminish towards the wide end. At a distance of about 12 to 13 in. from the point where the flame acts upon the copper plate the temperature will remain steadily at about 56° C., with the temperature of the room at 22° C. As long as the temperature of the room remains nearly the same the temperature of the plate at any given distance from the burner will also remain at the same point. This constancy is due to the fact that the heat which is conducted through the copper plate with constant rapidity from its source—the burner—is radiated into the surrounding air at an equally constant rate, and as one passes towards the wide end of the plate from the burner, trials with the thermometer show that there may be found an infinite number of points in succession at which the temperature is very nearly constant.

In order to use the paraffin itself as an indicator of the proper temperature, and in that way dispense with the thermometer altogether if desirable, it was necessary to use a new type of cup in which to melt the paraffin. The paraffin-cup or trough *p* shown in the figure is made of copper, tin-lined, and is 6 in. long, $1\frac{1}{2}$ in. wide, and $1\frac{1}{4}$ in. deep. In practice the cup is half filled with paraffin and placed lengthwise on the copper plate, with its narrowest side towards the flame, and about 9 in. from it, as shown in the cut. The paraffin-cup may be covered with a slip of glass to exclude dust. If the burner plays upon the plate as directed, and the trough is in the proper position, in about an hour it will be found that the paraffin in the trough has been melted at the end nearest the burner but has remained congealed at the other. Moreover, it will be found that the point where the melted comes in contact with the nearly frozen paraffin is very constant, and it is just at this point where it is safe to place objects which are to be imbedded. The paraffin which remains congealed in the trough is represented in the cut by the shading at the remote end of the trough, the clear space below the dotted lines nearest the flame indicating the portion which remains molten.

It is clear from what has preceded that a shorter cup or trough filled with soft paraffin melting at 36° C. may be placed still farther away from the burner, alongside of the vessel containing hard paraffin fusing at 56° C., while mixtures of turpentine and paraffin, or chloroform and paraffin, would remain molten at a still greater distance from the flame.

The applications and possibilities of this new device will be readily appreciated by histologists and embryologists, since it can be quickly seen if objects are in danger from overheating by simply noting whether the point where the paraffin remains molten in the trough has advanced farther from the flame. This can be easily observed through the transparent cover of the trough.

For large laboratories, where a number of students are engaged in imbedding, a simple modification of this device suggests itself. For such a purpose a horizontal disc of sheet copper, of the same thickness, but 3 ft. in diameter, would afford room for a large number of paraffin imbedding-troughs, which could be arranged in a circle around and some distance from the centre, at which point a larger burner would be applied underneath. The temperature in such a device would diminish from the centre towards the periphery of the disc. The troughs would be placed upon different radii upon the surface of the disc, just as two or three troughs may be placed upon different radii of the triangular plate, which is practically the sector of a disc, as described above.

For imbedding delicate objects, small cups made of tin-foil, pressed into shape in circular tapering moulds, may be satisfactorily employed with this apparatus, in the same way as the troughs.

The device described above can be made by any coppersmith for about two dollars.

Imbedding Objects for the Rocking Microtome.*—Herr S. Schönland advises the following method for imbedding objects in paraffin. It is especially intended for use with the Cambridge rocking microtome, which requires perfect saturation of the object with paraffin. The object, first stained in borax-carmine, is placed in 30 per cent. spirit, to which a trace of acetic acid has been added. It is then transferred to stronger and stronger spirit. From the strongest alcohol it is transferred to a vessel (holding 3–4 ccm.) half filled with oil of cloves and half with spirit. When the specimen has sunk to the bottom, it is placed in pure cloves, and after an hour in turpentine oil, wherein it remains for about six hours. It is next immersed in paraffin for eight to ten hours. The temperature of the paraffin, which has a melting-point of about 45° C., is not allowed to rise above 47°, but just before imbedding it is advisable to heat the paraffin a little more, as air-bubbles are thereby avoided. The ordinary paper boxes are used for imbedding.

Imbedding Eyes in Celloidin.†—Dr. W. B. Canfield recommends that eyes should be hardened in Müller's fluid and then after-hardened in spirit. Schultze's diffusion apparatus is of great use for preventing shrinking of the eye. A small incision is then made tangentially to the sclera and also on the corneal edges, and the eye put in equal parts of absolute alcohol and sulphuric ether. After twenty-four hours it is transferred to pure ether, and the next day to a thin watery solution of celloidin in ether. In order to get rid of air-bubbles, the eye is to be so immersed that the incisions are uppermost. After twenty-four hours the eye is put in thick celloidin, the vessel being left partially uncovered, until the celloidin is hard enough to

* Bot. Centralbl., xxx. (1887) pp. 283–5.
† The Microscope, vii. (1887) pp. 99–101.

be cut. The block is then cut out, softened a few minutes in absolute alcohol, dipped once more in the celloidin solution, and put on a cork.

The block when cut out is better softened in ether and at once transferred to the cork. This procedure is not only more simple but more effective. The preparation on the cork is then exposed to the air until quite stiff and then allowed to float in 84 per cent. spirit until required. By this method sections of the whole or any part of the eye may be made. Anilin colours are to be avoided as they stain the celloidin. Logwood also stains it, but acetic acid (1/2–1 per cent. solution) withdraws it in twenty-four hours, leaving the tissue still coloured. Rosin may be used as a contrast stain. Cedar and origanum oils are the best for clarifying.

Imbedding in Vegetable Wax.*—Dr. P. Francotte who has recently investigated the qualities of vegetable wax as an imbedding medium, finds, that whatever its potentialities may be, it is inferior to paraffin. The method he advises is as follows:—After the object is fixed, hardened, and stained, or not, it is laid in 94° spirit, kept at a temperature of 48° C. in a water-bath. The wax is then added gradually, and in small pieces, until the consistence is that of soup. If the object be small, the heat is continued until all the alcohol has evaporated. If the object be large, the alcoholic mass and the object are poured into a bulb fitted with a straight cooler or tube, about three feet long; as the spirit condenses, it falls back into the bulb, and when the object is properly saturated it is removed to another vessel and the spirit driven off. The object is then oriented in a metal or cardboard box filled with warm wax. When cool, the mass may be cut with a microtome or by hand. The sections are fixed to the slide with albumen or gum. The slide is then heated in a water-bath to 50° C., and alcohol added until the wax is dissolved. If not coloured *en masse*, the sections may now be stained and then dehydrated, and afterwards cleared up in cloves, cedar, or bergamot oil, or they may be mounted in glycerin.

The advantages this medium has over paraffin are, that it dispenses with such fluids as toluol, xylol, benzine, and chloroform, and hence is suitable for animal tissue where these fluids are contra-indicated. It is available also for the examination of micro-organisms in tissues; in this it is superior to paraffin, for it is always difficult and frequently impossible to discover microbes in tissues impregnated with paraffin. Its most important disadvantages are, that it is difficult to obtain sections thinner than 0·01 mm., and to make out when the object is properly saturated.

Baskets for the suspension of objects in paraffin.†—Mr. H. Garman recommends the use of wire baskets for suspending objects in paraffin. Such a basket is easily made by coiling annealed wire as shown in fig. 191, beginning at the centre of the bottom and working outwards to the margin, then making the handle *h*, and finishing with a triangular base *b*. In use it is placed in the melted paraffin, the triangular base supporting and keeping it from the bottom of the paraffin basin, and it can be removed by means of the projecting handle, which is made of such length that it does not interfere with the glass cover of the basin. For very small objects a hammered wire spoon, like that used by Dr. Mark, is mounted in the same way as the basket (fig. 192). This method of suspending objects in paraffin

* Bull. Soc. Belge Micr., xiii. (1887) pp. 140–4.
† Amer. Naturalist, xxi. (1887) pp. 596–7 (3 figs.).

has resulted from attempts to avoid long handles or other belongings of the baskets, that prevent the close fitting of the plates of glass used to cover the paraffin dishes.

Fig. 191.

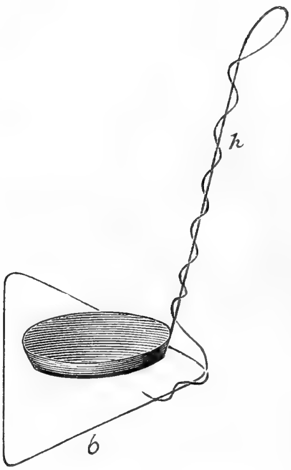


Fig. 192.

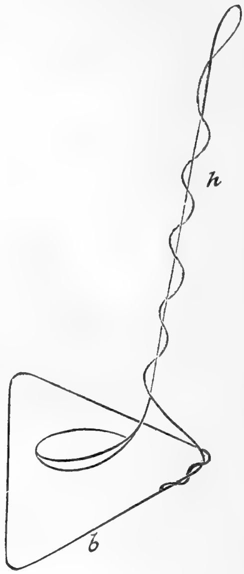
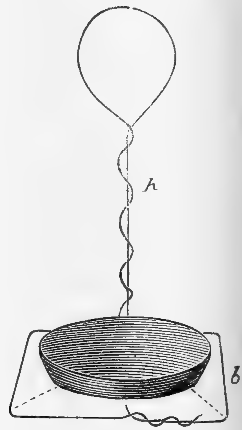


Fig. 193.



Francotte's Sliding Microtome.*—Dr. P. Francotte has designed an instrument capable of making most perfectly regular sections of a limited size, 5 mm. at most. The body of the microtome is like Ranvier's, and the object to be cut is placed in a cylinder which slides in the microtome tube. The latter piece does not rub against the metal walls, but is supported in the cylinder by means of pieces of cork. At the base of the tube is a scale for noting the movements of the screw, and at the side is an index for showing in what limits the piece can move.

Upon the circular table of the microtome is fixed by three screws a plate larger than the table. In the centre is an opening in order that the piece may be raised, and at the side a groove with triangular vertical section and sharp edges; within this groove the object-carrier runs. The carrier slides merely on two longitudinal bands so as to lessen the friction as much as possible. The groove maintains a rectilinear and regular movement; the two metal bands keep the knife moving in the same plane. The razor is fixed to the carrier by means of a metal piece and two screws, and in order to obtain the desired stability the instrument is fixed to the work-table by a binding screw. For the rest, the manipulation of the instrument is very simple, and M. Francotte thinks it will suffice for most histological investigations.

Ryder's Automatic Microtome.†—This instrument (figs. 194 and 195) has been devised by Prof. J. A. Ryder, in order to facilitate the preparation

* Bull. Soc. Belge Micr., xiii. (1887) pp. 149–50.

† Amer. Natural., xxi. (1887) pp. 298–302 (2 figs.). Cf. also The Microscope, vii. (1887) pp. 179–83 (2 figs.).

of sections for large classes, and also for the rapid preparation of series of sections in ribbons in embryological work, in which the element of time becomes a serious consideration. One hundred sections per minute can be readily cut with it.

The device is small and compact and is also automatic; the cutting takes place as fast as it is possible to move a vibrating lever up and down through a distance of 3 in. with the right hand. The designer considers that "nearly all other automatic microtomes are costly, unwieldy, large, and heavy, or else very complicated and liable to get out of order. The only exception in part to this rule is the rocking microtome, made in Cambridge, England; but it cuts in an arc, so that the sections are segments of a hollow cylinder, and not parts of a perfect plane; besides, the rocking or vibrating arm admits of only a very limited movement, so that the instrument is suitable only for cutting sections of objects of very limited dimensions; nor is the position of the block adjustable. Moreover, in none of the automatic microtomes now in use is it possible to place the knife at right angles or any other desired angle to the direction in which the block to be cut is moved—a great desideratum in botanical or other work in which an inclined knife is necessary. In order to supply an instrument serviceable especially to teachers, as well as to all classes of students, botanists, pathologists, histologists, and zoologists, the designer has attempted to bring together all the desirable features of previously invented instruments, in as simple, convenient, and compact a form as possible, without sacrificing rapidity and efficiency of action."

FIG. 194.

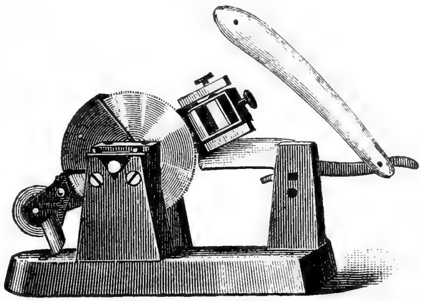
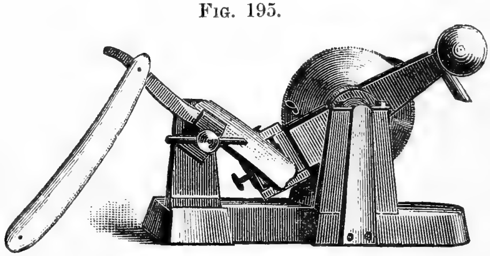


FIG. 195.



The working parts are an oscillating lever, which is provided with a clamp at one end into which paraffin-holders are adjusted, and at the other with a simple handle. This lever rests upon trunnions on either side, and these in turn rest in triangular notches at the top of the two pillars between which the lever oscillates. At the cutting end of the lever a spring pulls the lever down and effects the sectioning and also the adjustment for the next section. The lever is pushed over and adjusted for the successive sections by a hollow screw, through which passes the trunnion on the side away from the knife. This screw is fixed to a toothed wheel, 3 in. in diameter, which revolves close by the side of the oscillating lever. The toothed wheel and screw is actuated by a pawl fixed to the side of the lever near the handle. The number of teeth which this pawl can pass in a single vibration downward is controlled by a fixed stop screwed into the under side of the oscillating lever near the handle; the end of this stop striking on the top of the bed-plate thus brings the lever to rest at a constant point

in its downward excursion. An adjustable sector by the side of the toothed wheel throws the pawl out of gear after a given radius of the wheel has been turned through an arc embracing the desired number of teeth. This adjustment is also effected before the block, containing the object to be cut, reaches the edge of the knife. The adjustment for the next section is therefore effected while the surface of the block is not in contact with the under side of the knife, so that no flattening or scraping effect is produced on the surface of the block in its upward passage past the knife.

The movement of the vibrating lever being arrested at each down stroke at one point and the pawl which catches into the notches in the toothed wheel being released at any desired point by the action of the adjustable sector, it is possible to adjust the apparatus with great accuracy for cutting sections of any desired thickness. If a given radius of the wheel is moved through the arc embraced by a single tooth, sections are cut, having a thickness of only 1/10000 of an inch, or 0·0025 mm.—a thickness which is only practically possible with paraffin imbedding and a very keen razor. If more teeth are taken by the pawl, any thickness of section is possible up to about 1/400 of an inch, or 0·0625 mm. (The screw which adjusts the block for cutting has exactly fifty threads to the inch, and there are two hundred teeth on the periphery of the toothed wheel. The value of a single tooth is, therefore, $1/50 \times 1/200 = 1/10000$ in.).

A freezing attachment, which has lately been appended to the apparatus, shows that frozen sections can be made with as great rapidity and success as those cut from objects imbedded in the paraffin block, and very nearly, if not quite, as thin. Other auxiliary apparatus makes it possible to cut celloidin sections. This is effected by means of alcohol conducted by a tube from a reservoir to the knife, over which the fluid will run and drain into a tray below in such a way as not to come in contact with any other parts of the machine. This tray fits into a recess in the side of the bed-plate of the instrument just below the knife, and into this tray the celloidin sections may be allowed to drop as fast as cut.

The paraffin-holders are square and 7/8 in. in diameter, so that a block of that size may very readily be sectioned. For the botanist, one of these holders is provided with a movable side and screw for clamping objects, so that rather tough stems may be firmly held between blocks of cork, while the more delicate vegetable tissues, or such as must be imbedded in fresh carrot, soaked in gum and hardened in alcohol, may also be firmly held for sectioning by the same device, provided the pieces of carrot are first trimmed into the right shape. The same style of holder is equally applicable for holding the corks—if properly trimmed—upon which tissues are imbedded in celloidin or in gum. This style of holder also enables one to imbed very long objects entire in paraffin—such as earthworms—and to cut them as a single piece, provided the surrounding paraffin is carefully trimmed so as to have two opposite sides parallel. An object 6 in. long and 3/4 in. in diameter, imbedded in this way, may be cut into an absolutely continuous series of sections without losing any essential portions. This is accomplished by slipping the block through the quadrangular clamp for the distance of 1/2 in. every time 1/2 in. of the object has been cut off in the form of sections. 1/2 in. is the length of block which can be cut at one time without readjusting the feed-screw which moves the block and vibrating lever over towards the knife, the whole being kept firmly in place against the face of the hollow screw by a strong spring which presses against the end of the trunnion on the outside of the iron pillar on that side of the instrument where the knife is fastened, so that all the sections are of exactly the same thickness, from

first to last. "Cutting up large objects in the manner above described is not possible with any other form of microtome yet constructed."

Almost any section-knife—wide or narrow-bladed—will fit into and be firmly held by the knife-clamp, which is, however, intended more especially to hold an ordinary razor.

For ribbon-cutting by the paraffin method, the block containing the object, after it is trimmed and soldered to the paraffin with which the holder is filled, by means of a heated wire, is covered with a thin coat of soft paraffin or "paraffin-gum," and of which "chewing-gum" is made. (Chewing-gum may be rendered available for this purpose, if it is melted at a temperature somewhat above boiling, when the sugar which it contains will separate as caramel, leaving the pure paraffin-gum, which may be drained off and used as directed, if the manipulator should find it difficult to get the paraffin-gum of commerce.) This enables one to cut ribbons of any desired length, since the softer paraffin at the edges of the successive sections sticks them together by their margins as fast as they are cut. The ribbons may be allowed to fall upon a slip of paper, which may be drawn out, as fast as the sections are cut, from under the bed-plate of the instrument, beneath which there is a space left for this purpose between the three toes or tripod upon which the whole apparatus rests. The edge of the knife also remains in the same plane, no matter at what angle the cutting edge is placed with reference to the direction in which the block to be cut is moved, just as in the best forms of the sledge microtome.

A section flattener can be attached in the form of a roller of hard rubber which turns loosely on a rod held parallel with the knife-edge. The roller is placed with its centre somewhat in advance of the knife-edge and the rod supporting it may be fastened to the back edge of the knife or be clamped in the position of the support which holds the tube conveying the alcohol to the knife when cutting celloidin sections.

In cutting celloidin or collodion masses, it has been found that the greater the inclination of the knife the better the results, and it may be found expedient to devise a special form of clasp for cutting celloidin.

Mall's Section-smoother.*—Dr. P. F. Mall recommends a section-smoother constructed on the following principle. It consists of a rubber rod about $1\frac{1}{4}$ cm. in diameter, which rotates *loosely* on a solid axis. The

FIG. 196.

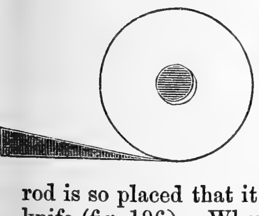


FIG. 197.

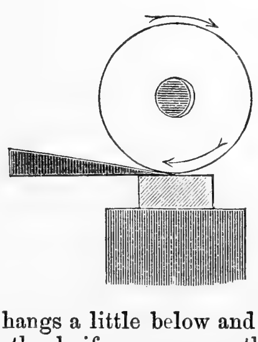
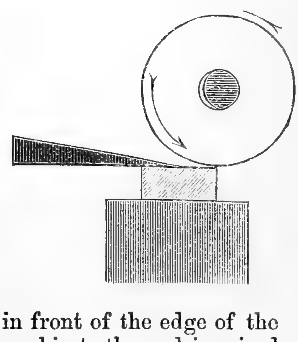


FIG. 198.



rod is so placed that it hangs a little below and in front of the edge of the knife (fig. 196). When the knife passes over the object, the rod is raised

* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1887, pp. 2–3 (3 figs.). Cf. Amer. Naturalist, xxi. (1887) p. 597 (3 figs.).

to an extent equal to the thickness of the section, and is thrown above and a little behind the edge of the knife (fig. 197), so that the section is prevented from rolling as it slides upon the knife. When the knife is pushed back preparatory to making the next section, the rod rolls over the preparation, and in consequence of the play of its axis, is kept free from the edge of the knife (fig. 198). The section does not stick to the rod as is the case in Jung's section-smoother.

Extemporized Section-smoother.*—Dr. W. C. Borden has invented a device for preventing sections imbedded in paraffin from curling. It consists of a bent glass tube, one end of which is passed through a hole in the table and into the other is fitted a camel's-hair brush. For most sections a round brush with long hairs is the most suitable, but for large sections a flat brush is to be preferred. The brush is to be so arranged that it lies lightly yet closely on the surface of the object to be cut. The thinnest and most delicate sections are not injured by this method and as the harder paraffins allow the thinnest sections to be cut, great success is obtainable by the combination of this flattener and hard paraffin.

Making Sections of Injected Lung.†—Mr. A. J. Doherty injects the lung *in situ* through the right ventricle with a stiff but freely flowing carmine-gelatin mass (Carter's formula), care being taken to throw the mass in slowly and with a uniform pressure, and not to over distend the vessels, either by injecting too rapidly or for too long a time. When properly filled the pulmonary arteries and veins are ligatured, the lungs are removed from the body, and are then distended with 90 per cent. spirit injected through the trachea, which is afterwards to be closed with a clip or bull-nose forceps. The lungs are then weighted with lead and placed in a quantity of 90 per cent. alcohol. In twenty-four hours they are taken out, the clip is removed from the trachea, and as much alcohol as possible is drained from the organs. After this, they are to be redistended with 90 per cent. alcohol and placed in a fresh quantity of spirits of that grade as before. This process is to be repeated on the fifth and tenth days, and at the end of a month the lungs will be found to be hardened without being in the slightest degree collapsed. Cut from one of the lungs, preferably at the root and transversely across a bronchus, a piece, say 1/2 in. square and 1/4 in. thick; transfer it to a glass beaker half filled with methylated chloroform, place the beaker in a water-bath and heat to 100° F. Shake the vessel occasionally to facilitate the saturation of the tissue with the chloroform, and in half-an-hour, add very gradually (i. e. in small pieces, one after the other) about 50 per cent. of paraffin. Keep the lung in this mixture for one hour, and then transfer to a bath of pure paraffin, kept for two hours at 3° F. above its melting-point. The tissue will then be thoroughly infiltrated with the paraffin and beautiful sections can be made with a hand microtome and a sharp razor. The sections are passed through three consecutive changes of warm temperature, and finally are mounted in balsam and benzole.

GROULT, P.—**Le nouveau Microtome à levier.** (The new lever microtome—Hansen's.) [Constructed generally on the Thoma plan, its characteristics being the use of a lever and the arrangement for cutting either dry or immersion. The object-holder is connected with the short arm of a lever, the arms of which are as 1 to 5. At each complete turn the micrometer-screw on the right, which acts on the long end of the lever, rises or falls 0·5 mm., so that the object-holder is moved 0·1 mm. Each of the fifty teeth of the head of the screw

* The Microscope, vii. (1887) pp. 97–8 (1 fig.).

† Ibid., pp. 101–2.

therefore represents a movement of the section through 0·002 mm. There is also an automatic arrangement. For wet cutting a fixed tray is added. A second form of the instrument has a movable tray, which can be lowered for dry or raised for wet cutting. In the latter case the object-holder is immersed. It is claimed that this plan of construction obviates the inconveniences of those microtomes which are reversible for immersion.]

Le Naturaliste, VIII. (1886) pp. 241–3 (8 figs.).
Journ. de Micrögr., 1886, pp. 507–12 (6 figs.).

HAENSELL, P.—**Le Microtome et ses applications à l'anatomie de l'œil.** (The microtome and its applications to the anatomy of the eye.)
Bull. Clin. Nat. Ophthalm., IV. p. 106.

REDDING, T. B.—**Uses of Celloidin.** *The Microscope*, VII. (1887) pp. 43–5.

ROSENBERG, P.—**Eine neues Microtom.** (A new microtome.)
Anat. Anzeig., 1886, pp. 211–3.

TYAS, W. H.—**Golding-Bird's small Ice Freezing Microtome.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 70.

(4) Staining and Injecting.

Fixing and Staining Nuclei.*—Mr. D. H. Campbell writes, that the following methods have been found to give excellent results in the study of nuclei. The observations were chiefly made with the mother-cells of the spermatozoids of various ferns, but the nuclei of vegetative cells also gave very instructive preparations.

In order to fix the nuclei, the prothallia were placed in aqueous solutions of chromic or picric acid or corrosive sublimate. The chromic acid solution should be a 1 per cent. solution; the others concentrated. In these solutions they should remain from one to two hours, though in the corrosive sublimate solution less time is required. The chromic and picric acid preparations must be washed in several waters before staining. It has been found a good plan to leave them overnight in abundant fresh water before the final washing. The sublimate preparations may be transferred to absolute alcohol, in which they should remain several hours.

The specimens are now ready for staining. The best results were obtained with hæmatoxylin and gold chloride. The secret of good hæmatoxylin staining is to use a very dilute solution; three or four drops of the prepared solution in a watchglassful of distilled water, and to allow the specimens to remain in this for at least twenty-four hours.

After taking the specimens from the hæmatoxylin solution, they must be passed successively through 50 per cent., 70 per cent., and absolute alcohol before mounting. Half an hour is usually sufficient for each of the alcohols. For immediate examination they may be mounted in glycerin, but for permanent preparations first in origanum oil, and then transferred to Canada balsam (dissolved in chloroform.)

The gold chloride method is simpler, and is found to answer admirably for specimens fixed in picric or chromic acid; but with those fixed with the corrosive sublimate or alcohol, it has not answered so well. A few drops of 1 per cent. gold chloride in water are placed in a watchglass almost half-filled with distilled water, and the specimens are allowed to remain from one-half to one hour, the solution being kept in the dark. Strasburger recommends a trace of HCl, but with the picric and chromic acid preparations, although thoroughly washed, the author found this unnecessary. The specimens are then thoroughly washed, being at the same time exposed to the light and finally mounted in glycerin. With alcohol material, hæmatoxylin was found to give the best results.

The above notes embody (the author says) nothing specially new, but may be useful as a memorandum of work actually done.

* Bot. Gazette, xii. (1887) p. 40.

Staining Elastic Fibres with Victoria Blue.*—Dr. L. Lustgarten states that Victoria blue stains elastic fibres in the fresh condition if the preparations are hardened for 24 hours in chrom- osmic-acetic acid and then in spirit. 1–2 parts of an alcoholic solution of Victoria blue are mixed with four parts of water. Then alcohol and bergamot oil. The hue is blue-green. Nuclear staining is more successful with a watery solution, followed by alcohol, bergamot oil, and xylol balsam.

Staining Peziza Specimens.†—Mr. C. F. Fairman decolorizes the *Pezizæ* by soaking in a solution of corrosive sublimate (1 to 2000 aq. dist.); then washing from precipitated calomel by agitation in distilled water and macerating in 90 per cent. alcohol for twenty-four hours. For immediate examination, lower for a few seconds in a strong hæmatoxylin solution, wash in distilled water, or if preferred, use the dilute hæmatoxylin fluid. (See *supra*, p. 687.)

Staining relations of Leprosy and Tubercle Bacilli.‡—Dr. F. Wesener, who has recently investigated the receptivity of these bacilli for anilin dyes in order to ascertain if any crucial difference existed between these micro-organisms, finds that a diagnosis between the two must be made from several kinds of proof and not from one alone. With regard to the reaction to the simple anilin solutions (Weigert's method) he found that methyl-violet was more efficient than fuchsin for tubercle bacilli, but that such distinction did not hold good for leprosy bacilli; nor did he find a minimum time test of a satisfactory nature, although leprosy bacilli took up red dyes rather quicker. Nor did the more complicated solutions (Koch's, Ehrlich's, Ziehl's methods) afford any satisfactory test.

The author in view of the fact that a diagnosis must be made from differences of degree, advises the following stains if the Ehrlich method has demonstrated the presence of bacilli, and it is desirable to ascertain if the bacilli be those of leprosy or tubercle.

(1) Methyl-violet (in concentrated watery or dilute alcoholic solution) for twenty-four hours: decolorize in nitric acid. (2) Fuchsin as above. (3) Baumgarten's methods. (4) Four to six minutes in a watery solution of fuchsin: decolorize in alcohol. (5) The same with methyl-violet.

Staining Differences of Leprosy and Tubercle Bacilli.§—Prof. Baumgarten controverts the statement of Dr. Wesener with regard to the respective receptivity of leprosy and tubercle bacilli for anilin stains. By using a dilute solution of fuchsin and immersing the sections for 12–15 minutes, and then decolorizing in nitric acid (1–10) with after-staining in methylen-blue for 2–3 minutes and dehydration in absolute alcohol 3–4 minutes, the leprosy bacilli show red, the tubercle bacilli are unstained. Or the sections may be stained in the Ehrlich fuchsin for 2–3 minutes with subsequent procedure as above. Cover-glass preparations give analogous results, for leprosy bacilli will stain in 6–7 minutes in a cold dilute alcoholic solution of fuchsin, but tubercle bacilli will not. Yet Prof. Baumgarten would not rely alone on colour reaction—the point at issue, by the way—but would also take into consideration the position and arrangement of the microbes and verify the results by inoculation experiments.

Decoloration of Bacteria stained with Anilin dyes.‖—Dr. A. Spina, starting from the observation that cotton fibre treated with tannin as a mor-

* Medicin. Jahrb. K. Gesell. der Aerzte zu Wien, 1886, pp. 285–91 (1 pl.).
† Bot. Gazette, xii. (1887) p. 85.
‡ Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 450–6.
§ Ibid., pp. 573–6. ‖ Allg. Wien. Med. Ztg., 1887, Nos. 15 and 16.

dant gives up anilin stains to acids very slowly, subjected some fission fungi to a corresponding treatment. Dry preparations of rotting meat infusion treated with a strong tannin solution, and then stained for twenty-four hours with anilin or methyl violet, were found to be thoroughly stained after acid, while the preparations not treated with tannin were either only faintly stained or not at all. The difference became more apparent if a saturated solution of tannin were used, and this peculiarity was found to affect all kinds of Bacteria alike. A similar effect, but less marked, was obtained with various albuminates and fats. By preparing a decomposing fluid containing tannin, the author found the same resistance to acids in living Bacteria.

Demonstration of Phloroglucin.*—Herr O. Lindt has discovered that vanillin in very dilute solution (1:1000) gives a colour reaction with phloroglucin and orcin, but not with resorcin. Both these bodies are, however, sharply distinguished from each other by the different colour given to these solutions. The phloroglucin is a bright red, assuming a violet-red tone later on. The orcin solution is a bright blue with a trace of red. The reaction is so sensitive that 0·000001 grm. of the dry substance can be easily recognized on the addition of a drop of the vanillin solution made according to the following formula:—Dissolve vanillin 0·005 grm. in spirit 0·5 grm., to this add water 0·5 grm., strong hydrochloric acid 3·0 grm. The reaction takes place so quickly that the disturbing influence of secondary appearances does not interfere with the histo-chemical investigation.

It is, however, necessary that the microscopical sections should be previously dried on the slide, because water impedes the reaction and lessens its intensity. It is further recommended that a control examination should be simultaneously carried on. By means of this solution the author has been able to determine the presence of phloroglucin in tissues which have been hitherto supposed to be devoid of it. On the other hand, phloroglucin was found to exist in considerable quantity in the tissues of certain leaves which later on became crimson, although the leaves of most plants which remain green in autumn contain little or none.

Dr. Lindt suspects that the red colour of certain leaves and plant stems is not less dependent on the presence of phloroglucin than on the existence of a certain quantity of tannin, for it is quite possible that the relations which exist between the latter and the red colouring matter may depend on a similar reaction of certain transformation-products due to the action of tannic acid on phloroglucin—a reaction comparable to the effect of vanillin on phloroglucin.

It may be mentioned that the presence of a mineral acid does not seem to be indispensable to the appearance of the reaction, for if vanillin, phloroglucin, and oxalic acid be dissolved in water and the solution evaporated to dryness, the residue is bright red.

Staining Preparations for Photography.†—Dr. P. Francotte gives the results of experiments in photographing preparations stained with various colours.

For picro-carmine preparations two baths are necessary—(1) The plate is steeped for two minutes in distilled water 200 cc.; ammonia 2 cc. (2) Then for two minutes in distilled water 200 cc.; ammonia 2 cc.; alcohol 10 cc.; solution of cyanin 1 : 500 in absolute alcohol 5 cc.

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 495–9.
† Bull. Soc. Belge Micr., xiii. (1887) pp. 151–8.

The plates are placed on blotting-paper and dried rapidly. They only keep for a few days.

For preparations stained with vesuvin, Bismarck brown, methyl-green, or picro-carmine with yellow and red stain, the formula which gives the best results is that of Mulman and Scolik:—1 gr. of quinoline red is dissolved in 500 cc. alcohol, and 50 cc. of an alcoholic solution of cyanin 1 : 500 is added. The plate is steeped for a minute in water 100 cc.; ammonia 1/2 cc. It is then transferred to a bath composed of the quinoline red solution 1 cc.; water 100 cc.; ammonia 1/2 cc., for one minute. The superfluous water having been removed with blotting-paper, the plate is dried in a stove at about 30°.

For preparations stained with any colour the following formula succeeds well:—Bath for two minutes in a watery solution of erythrosin 1 : 1000, 25 cc.; ammonia 4 cc.; water 175 cc. If the preparations are stained red, 1 cc. of an alcoholic solution of cyanin 1 : 500 is added.

Another formula is—Solution of erythrosin 1 : 1000, 25 cc.; solution of silver nitrate 1 : 1000, 25 cc.; water 50–100 cc.; and if the preparations are deeply stained with red, the author adds 5–10 cc. of an alcoholic solution of cyanin 1 : 500.

Dr. Francotte remarks that it is absolutely indispensable to use orthochromatic plates when dealing with coloured preparations, and if the stain be blue or violet, a yellow glass must be interposed between the light and the preparation.

For developing, the author prefers pyrogallic acid and sulphite of soda. Four baths are required:—(1) 10 gr. pyrogallic acid dissolved in 100 cc. of alcohol at 90°. (2) 100 gr. of pure sulphite of soda dissolved in 200 cc. distilled water. (3) 100 gr. of pure carbonate of soda dissolved in 200 cc. distilled water. (4) An aqueous 10 per cent. solution of bromide of potash.

In order to develope, 5 cc. of No. 1, 10 cc. of No. 2, and 5 cc. of No. 3 are poured into a vessel containing 100 cc. of water, and if the time of exposure be in excess, a few drops of No. 4 are added.

The time of development is about five minutes.

Fixing is performed in the usual way. If the plates are still coloured after the operation (and this often happens) they are immersed in a bath of spirit at 90°, to which a few drops of ammonia are added.

BIDERT.—**Ein Verfahren, den Nachweis vereinzelter Tuberkelbacillen zu sichern, nebst Bemerkungen über die Färbbarkeit der Bacillen und Aetiologie der Tuberculose.** (A process of authenticating the presence of single tubercle bacilli, with remarks on the staining capacity of the bacilli and the ætiology of tuberculosis.)
Berl. Klin. Wochenschr., 1886, Nos. 42, 43.
Cf. *Centralbl. f. Bacteriol.*, I. (1887) p. 55.

DEKHUYZEN, M. C.—**Ueber die Tinction.** (On staining.)
Centralbl. f. d. Med. Wiss., 1886, Nos. 51–2.

DOHERTY, A. J.—**The Staining of Animal and Vegetable Tissues.**
["The object of the present paper, which is addressed to professed biologists as well as to *dilettanti*, is twofold; firstly, to record the results of my own extensive researches into the properties of staining reagents; and secondly, to place before the microtomist in a condensed form an account of various processes adopted by other workers with the Microscope."]
Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 1–19.

GRIGERJEW, A.—**[On Ehrlich's Staining of Micro-organisms.]**
Russkaja Med., 1886, No. 42.

HERXHEIMER, C.—**Ein neues Färbungsverfahren für die elastischen Fasern der Haut.** (A new staining process for the elastic fibres of the skin.)
Fortschr. d. Med., IV. (1886) p. 787.

KAMENSKI, D. A.—**Eine neue Methode die Koch'schen Bacillen im Sputum zu färben.** (A new method of staining Koch's bacilli in sputum.)
Wratsch, 1887, pp. 276–7 (in Russian).

LATHAM, V. A.—**The Microscope and how to use it. XI. Injecting, &c.** (*contd.*)
Journ. of Microscopy, VI. (1887) pp. 169–79.

LUSTGARTEN, S.—**Victoriablau, ein neues Tinctionsmittel für elastische Fasern und für Kerne.** (Victoria blue, a new staining medium for elastic fibres and nuclei.)
Wiener Med. Jahrb., 1886, p. 285.

[MANTON, W. P., AND OTHERS.]—**Stains.**

["How often, for instance, we read of a new objective that promises wonders. Such and kindred productions, of great value withal, are examined and discussed, till the next new objective or what-not displaces it. All this is as it should be. But do we show the same enthusiasm and interest over a new stain that allows us, perhaps, to study some object more satisfactorily with a 1/6 than could formerly have been done with a 1/8? We think not. All this is wrong. Is the new apochromatic glass—granting, even, all that is claimed for it—of greater importance to us than the results of the studies in the anilin dyes that individualized the *B. tuberculosis*? There are many who hold that we have about reached the limit of perfection in lenses. Be this as it may, the goal certainly does not seem to be so very far distant. But the province of stains has not as yet been invaded to any very great extent. And especially is this true as regards differential staining."]
The Microscope, VII. (1887) p. 110.

REYNOLDS, R. W.—**Injecting and cutting sections of the Cat.**
The Microscope, VII. (1887) pp. 156–9.

UNNA, P. G.—**Ueber Erzeugung von Vesuvin im Gewebe und über Metaphenylendiamin als Kernfärbemittel.** (On the formation of vesuvin in the tissues and on metaphenylendiamin for nuclear staining.)
Monatschr. f. prakt. Dermatol., 1887, p. 62.

V., R. E.—**Permanganate of Potash as a Staining Medium for Micro Objects.**

[For examining tissues of plants. "It defines edges of cells, markings on cell-walls, &c., more strongly than other dyes."]
Engl. Mech., XLV. (1887) p. 346.

WEIGERT, C.—**Ueber eine neue Methode zur Färbung von Fibrin und von Microorganismen.** (On a new method of staining fibrin and micro-organisms.)
Fortschr. d. Med., 1887, pp. 228-32.

WELLINGTON, C.—**Staining and Mounting Plant Sections.**
The Microscope, VII. (1887) pp. 133–4.

(5) Mounting, including Slides, Preservative Fluids, &c.

Flask for dehydrating specimens to be mounted in balsam or paraffin.*—Dr. P. Francotte's dehydrator, the idea of which is taken from Schulze's apparatus,† consists of a broad-necked flask to hold about half a litre. This contains alcohol and sulphate of copper. Into this flask is passed a dialysing tube, 5–6 cm. in diameter. It is closed above by a plate of glass, and below by a piece of parchment paper. The flask is plugged with a muslin bag filled with quicklime. The flask contains a float for marking the strength of the spirit from 94°–100°. A similar float is placed in the dialysing tube, and when the spirit in this tube is of 100°, it is emptied into the flask. The specimen is placed in the tube along with alcohol at 94°, and care has to be taken that the level of the liquid in the tube is the same as that in the flask. The apparatus works more quickly in a warm place.

Permanent Preparations on firm media.‡—Dr. J. Soyka when employing firm opaque nutritive material, as bread, potato, rice, uses round glass vessels about 6 cm. in diameter and 3 cm. high. The edge is bent outwards at the top for about 1 cm. and well ground, so that a plate of glass about 8 cm. in diameter can be cemented on. These vessels are then carefully stuffed to the height of 1 cm. with the medium, and the surface of the latter carefully levelled. After having been sterilized and inoculated with the cultivation the sterilized cover is cemented on. Pure cultivations, as bread and potato, will keep for at least two years, and thus are always ready

* Bull. Soc. Belge Micr., xiii. (1887) pp. 146–7.
† See this Journal, 1886, p. 537.
‡ Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 542–4.

for demonstration purposes. In an analogous manner may be preserved macro- and microscopical preparations. For this purpose small glass vessels like watch-glasses with flat bottoms are used. The floor is about 5 cm. in diameter, and the walls may ascend vertically or obliquely. Upon these a thin glass cover is placed, after the nutrient medium, with the bacteria to be cultivated, has been poured in. The organisms may or may not be developed in an incubator. Low powers are always available for inspecting the results of this method through the cover-glass, and if the gelatin or agar layer be very thin higher powers can be used. Before closing permanently it is advisable to wash the surface of the gelatin, &c., with a sublimate solution 1 : 1000. Drops of moisture which may condense on the cover and so obscure the colonies may be avoided by placing on the top a piece of warm glass or metal.

Use of Styrax in Histology.*—Dr. P. Francotte recommends styrax instead of balsam when the latter renders the object too transparent, e. g. for bacteria and in the study of karyokinesis styrax gives a greater resolution than balsam, while its slightly yellow tint is eminently favourable for photographic purposes. The author has obtained with ordinary plates excellent figures of the cells in the branchiæ of larvæ of salamander from specimens mounted in styrax, while similar preparations mounted in balsam required isochromatic plates or the use of chrysoidin previous to the eosin.

No excess of balsam necessary.†—Mr. J. E. Whitney emphasizes the fact that there should not be any surplus balsam to remove from around the cover. Experience soon learns to graduate the amount so that it will fill the required space. The balsam slide and cover should be exactly centered, and if the balsam happen to be too thick a very slight amount of heat will make it flow to the edge. It is a good rule to mix a little less balsam than seems necessary, as a little pressure will squeeze the balsam right out to the edge. When a cell is used it is impossible, however, to avoid some excess of balsam, as it needs to exude slightly around the cover to drive out the air from the cell; but even in this case, if carefully graduated to the cell, the excess need not be noticeable, and it can be covered with a ring of cement without being cleaned away at all.

Mounting Opaque Objects.‡—Mr. C. M. Vorce deprecates the use of pasteboard slides for mounting opaque objects; for even when of heavy tarboard they bend so readily as to crack or loosen the covers very easily, and, unless well saturated with some resinous varnish, are liable to mould or to take up moisture and deposit it under the cover. Even covered with paper they do not stand reasonable wear. Wooden slips are vastly better, and can be cheaply made by boring a hole centrally edgewise through a piece of wood 1 in. thick and 3 in. long of any width, and slitting it upon a saw table. But for this class of objects, for which low powers will ordinarily be sufficient, glass is the best material, and admits of examining both sides of the object. For objects that must be viewed uncovered and on both sides, no other mount will equal two of Pierce's capped cells mounted back to back with the object between and fixed in a wooden slip, either temporarily or permanently, or on a metal plate.

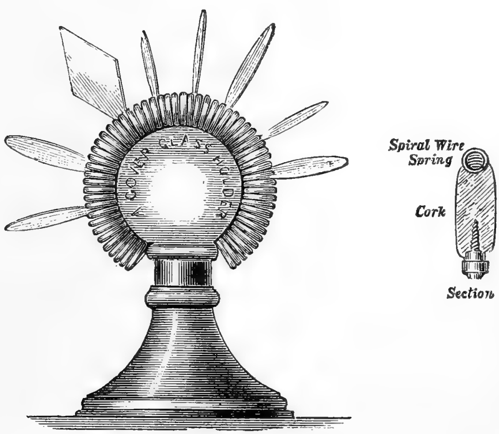
Mounting Opaque Objects on a Micrometer Background.§—Mr. R. Parkes writes :—" Most people on looking at an object under the Microscope

* Bull. Soc. Belg. Micr., xiii. (1887) pp. 144–6.
† The Microscope, vii. (1887) pp. 98–9.
‡ Amer. Mon. Micr. Journ., viii. (1887) pp. 92–3.
§ Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 58–9.

for the first time wish to know the natural size of the object exhibited, and for all opaque objects which could be mounted on a white, black, or coloured background, this information can be best attained by printing on the ground a scale ruled, say, one hundred lines to the inch, and upon which the object can be mounted, when its size will be at once apparent. I have engraved and brought down for presentation to the Society a ruled plate and other requisites, which will enable those members who care to do so, to produce any number of scales required. The plate before being used should be cleaned with turpentine, and the colouring matter rubbed in dry, lampblack, or any other powder colour will do, the excess colour being wiped off by passing a piece of tightly wrapped wash-leather across the plate. A piece of smooth wood or glass should then be taken, and soap or bees'-wax drawn across the face, and the paper about to be printed on should be laid upon it, the soap making it adhere to the face and keeping it straight. The soap or wax should then be passed over the paper, taking care to have a smooth and even film. The paper being thus prepared should be placed on the plate and the back rubbed lightly with the steel burnisher provided, and, on removing it, a clear impression of the scale will be found imprinted on the surface. If ordinary note-paper be used, many objects can be well illuminated by sending light through from the mirror of the Microscope. I have also engraved for the Society a metal micrometer ruled 100, 250, 500, and 1000 lines to the inch, which the members will find useful for measuring opaque objects. It has the advantage of not being so liable to break as the glass micrometers, and can be readily used with all powers up to 1/6 in. objective."

Cover-glass Holder.*—Dr. F. L. James describes the device (fig. 199) for holding cover-glasses after they are cleaned and ready for application to the slip. It consists of a coil of brass spiral spring wire bent round a

FIG. 199.



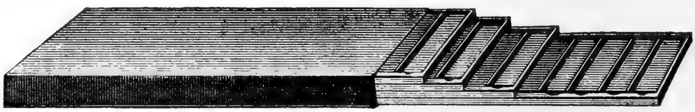
cork, which has been grooved to receive it. The method of using is illustrated by the cover-glasses in position on it.

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 145 (2 figs.).

James's Improved Slide Cabinet.*—Dr. F. L. James fastens, by marine glue, to the under side of each tray, pieces of vulcanized indiarubber, 1/2 in. in diameter, and 1/8 in. in thickness. These pieces are so arranged that one of them comes on each end of the slide beneath it in such manner that the slide is prevented from rising up against the bottom of the superincumbent tray. The slips in the upper tray are held in place by similar bits of rubber fastened to the cover of the box.

Griffith's Pocket Slide Cabinet.†—Mr. E. H. Griffith's cabinet (fig. 200) is intended especially for pocket use. It is similar to another already in the market, but in the place of rack-work in that, trays are used in this. A feature in its favour, that will be appreciated by those who carry slides in pockets, is its security from opening.

Fig. 200.



BAKER, S. W.—**Wax Cells.**

[Made by building up layers of artists' wax on the slide, which is placed on the turning-table, and a cut made through the first layer of wax the size of the cover-glass intended to be used, and the centre taken out; a cut is then made with a needle a little inside of the first cut, extending down to the glass; the centre is then removed and another cut made through the wax a little outside of the first cut, leaving a wall of wax to form the cell. This is finished by smoothing with a piece of ivory, shaped like a chisel, thoroughly varnishing, inside and out, with Brown's cement. By using dark-coloured wax for the first sheet next the slide, and leaving it as a bottom to the cell, a background can be made to suit any object.]

Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 196.

BROKENSHIRE, F. R.—**Mounting without Pressure.**

Scientif. Enquirer, II. (1887) pp. 135–8.

CALDWELL, C. T.—**New Cement.**

["It is simply the article sold at the paint and oil stores under the name of 'hard oil finish.' . . . It runs freely, makes smooth rings, dries readily and quickly, and is extremely adhesive. It is cleanly."]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 98–9.

ELIEL, L.—**Gums and Pastes for Labels.** *Engl. Mech.*, XLIV. (1887) pp. 535–6.

HOPKINS, G. M.—**A quick method of mounting dry objects.**

[Recommends metal rings with a narrow internal flange at the top for the cover-glass, and a wider external flange at the bottom for attachment to the slide.]

Engl. Mech., XLV. (1887) pp. 310–11 (2 figs.), from *Scientific American.*

JAMES, F. L.—**Device for centering and holding the slide upon the turntable.**

["It consists of the ordinary triangular jaws pivoted exactly opposite to each other, and the acute end of one of the slips resting against a good strong spring. The slip is shoved into place from the open end of the jaws, opposite to the end held by the spring. A slide placed between these jaws is held as firmly as in a vice, and the cell can be turned down or manipulated exactly as though it were in a lathe."]

Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 146.

KELLICOTT, D. S.—**Kaiser's Glycerin Jelly for Plant Sections.**

["Stained leaf sections are best shown in Kaiser's glycerin jelly to which a large per cent. of gelatin has been added."]

The Microscope, VII. (1887) p. 152.

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* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 146. † Ibid., p. 152.

Laboratory Notes.
[Preserving a specimen temporarily by applying a drop of glycerin at the side of the cover-glass in such a manner as to effect a union between the water and the glycerin; value of dried specimens of algæ, &c.]
Amer. Natural., XXI. (1887) pp. 477–9.

TRZEBINSKI, ST.—**Einiges über die Einwirkung der Härtungsmethoden auf die Beschaffenheit der Ganglienzellen im Rückenmark der Kaninchen und Hunde.** (On the influence of hardening methods on the condition of the ganglion-cells in the spinal cord of rabbits and dogs.) *Virchow's Arch. f. Path. Anat.*, CVII. (1887) p. 1.

WILLIAMS, C. F. W. T.—**Mounting in Castor Oil.**
[Cell to be made with Ward's brown cement and filled with best castor oil. "For plant crystals, such as raphides and the like, there is no preservative so good in my opinion as this oil."]
Sci.-Gossip, 1887, p. 138.

(6) Miscellaneous.

New Micro-chemical Reaction for Tannin.*—Experiments were made by Herr J. W. Moll, for the purpose of discovering a good reagent for tannin in the cells of plants, which should give a precipitate sharply separated from the surrounding fluid, and at the same time should show clearly the distinction between the tannins which colour iron green, and those which colour it blue. He obtained the desired results with lithium chlorate, copper acetate, copper nitrate, lead nitrate, and uranium acetate, the iron-salt used being the acetate. Of these copper acetate answered the best.

The living parts of plants to be examined were cut into small pieces and left in a saturated solution (7 per cent.) of copper acetate for from eight to ten days; longer immersion produces no injurious results. The sections were then placed on the slide in a drop of 0·5 per cent. iron acetate solution, but allowed to remain in it only for a few minutes, as longer action colours the cell-walls brown. After washing with water, and then with alcohol to remove the air and chlorophyll, they were examined in glycerin, or glycerin jelly, in which they remain unaltered for a lengthened period, even as much as two years. Or the sections may be removed directly from the copper acetate into alcohol, and examined afterwards with the assistance of iron acetate. The distinction between the tannins which give green and blue colours with iron were very clearly brought out. Thus in branches of *Fagus* the tannin-cells of the bark were coloured green, those of the pith blue.

Micro-chemical Reactions based on the formation of Crystals.†—MM. Klement and Renard have published an important paper on micro-chemical reactions. The methods available for the qualitative analysis of minute quantities of a substance are spectroscopic analysis, blow-pipe analysis, and micro-chemical reactions. The last method depends on the form and appearance of the crystals deposited by the action of reagents. Availing themselves of the researches of Boricky, Behrens, Streng, Lehmann, Haushofer, and others, combined with the results of their own extensive researches, the authors have produced the most complete account of the subject which has yet appeared. They describe the methods of research and the reactions, simple and characteristic, by which compounds of more than fifty elementary bodies may be identified in minute crystals recognizable under the Microscope. They also give a brief description of the processes of isolation and identification applicable to such compounds as the mineral constituents of rocks. The value of the treatise is much enhanced by the accompanying plates, eight in number, comprising nearly 100 figures of the forms of crystals obtained by the various reactions described in the text.

* Maandbl. voor Natuurwet., 1884. See Bot. Centralbl. xxiv. (1885) p. 250.
† Cf. Bull. Soc. Belg. Micr., xii. (1886) pp. 11 and 55–6.

ERMENGHEM, E. VAN.—**Manuel technique de Microbiologie d'après l'ouvrage de Hueppe Bacterien-Forschung.** (Manual of Microbiological Technique, after Hueppe's 'Bacterien-Forschung.') 500 pp., 76 figs. and 2 pls., 8vo, Paris, 1887.

JAMES, F. L.—**Elementary Microscopical Technology.** A Manual for Students of Microscopy. In three parts. Part I. The technical history of a slide from the crude materials to the finished mount.
107 pp. and 15 figs., 8vo, St. Louis, Mo., 1887.

" " **Clinical Microscopical Technology.** IV. The examination of Urine. V. Urinary Examinations: Inorganic Sediments.
St. Louis Med. and Surg. Journ., LII. (1887) pp. 289–91, 349–51.

[MANTON, W. P., AND OTHERS.]—**Elementary Department.** Third and Fourth Lesson. "Cleanliness is akin to godliness."
The Microscope, VII. (1887) pp. 146–7, 172–6.

SATTERTHWAITE, T. E.—**Practical Bacteriology.** 85 pp., 16mo, Detroit, 1887.

STÖHR, P.—**Lehrbuch der Histologie und der mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik.** (Manual of histology and human microscopical anatomy, including microscopical technique.)
199 figs., 8vo, Jena, 1887.

TAYLOR, T.—**Reply to Professor Weber.**
Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 116–9 (1 pl.).

WEBER, H. A.—**Microscopic examination of Butter and its Adulterations.**
[Concludes that "the microscopic methods as laid down by Dr. Taylor are of no practical value in the examination of butter for adulterations."]
Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 103–15 (1 pl.)

ZUNE, A.—**Etude microscopique et microchimique des Farines et des Fécules ou application du Microscope à la recherche de leurs falsifications et de leurs altérations.** (Microscopical and microchemical study of flour and starch, or application of the Microscope to the investigation of their falsifications and adulterations.)
Mon. du Praticien, II. (1886) pp. 166, 183, 211, and 263.

PROCEEDINGS OF THE SOCIETY.

Meeting of 8th June, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 11th May last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Crookshank, E. M., M.B., Manual of Bacteriology, 2nd ed., xxiv. and 439 pp., 29 pls. and 137 figs. (8vo, London, 1887) ..	*The Author.*
Lithograph of Microscopic Objects under the same magnifying power (the original was given to the late Dr. Carpenter, C.B., by Dr. Oliver Wendell Holmes, by whom it was drawn) ..	*Dr. P. H. Carpenter.*
Photomicrographs of Diatoms (× 840). No. 71, *Nitzchia* (?) with membrane attached; No. 66, *Cocconeis* (lower plate), with membrane attached; No. 175, *Cocconeis* (another negative) with membrane attached; No. 73, cast of *Heliopelta* (?); No.74 do.	*Col. R. O'Hara.*

Col. R. O'Hara's note on the "Means of Movement possessed by the Diatomaceæ" was read as follows:—

"In my former communication on this subject I stated that I believed that in many cases this means of movement consisted in an undulating membrane, and I gave a drawing of the same as attached to *Navicula*. I send now an enlarged photograph of the membrane as attached to *Pinnularia* or *Nitzchia*, and also an enlarged photograph of the lower plate of a *Cocconeis* with the membrane attached, and showing the undulations exactly, as I thought, I had seen in action as stated in my former note.

I further send two photographs of what I take to be casts of *Actinocyclus* or *Heliopelta*, many of which were in the gathering; but as I have not, so far, found them attached, they may be anything else. They will, however, explain most distinctly what I mean by the expressions, cast, and undulating membrane."

Mr. J. Deby said that he was stated at the last meeting (*ante*, p. 533) to have given slides of *Pediculus* to the Society. This was, however, an error, and the slides were much more interesting, as being the original slides which led to the discovery of the development of *Meloë*, a parasite of bees. The older naturalists, who did not know what these little lice-looking creatures were, had named them very erroneously *Pediculus Melittæ*. This "*Pediculus*" was the larva of a coleopterous insect, and undergoes a metamorphosis which the genuine *Pediculi* are exempt from.

Mr. Crisp read a letter from Mr. L. Dreyfus, late a member of the Council, who was now residing at Wiesbaden, accompanying a notice as to the Scientific Exhibition in connection with the 60th Congress of German Naturalists and Physicians, to be held in Wiesbaden from the 15th to the 24th September next, the attendance usually numbering about 3000. It is intended to be strictly scientific, not mercantile, and as its purpose will be to show at a glance the *latest and most perfected* instruments and apparatus which have been placed at the disposal of science and medicine in the last few years, anything that cannot lay claim to be ranked in this category will be rigorously excluded. No charge will be made for space, insertion in catalogue, or anything else, and the instruments will be

covered against risk by fire at the expense of the committee. Among the 17 groups is one for "Instruments of precision, with subdivision for Microscopy," as well as one for "Instruments and apparatus aiding instruction in Natural History." Applications should be addressed to the "Ausstellungs-Committee der 60. Versammlung Deutscher Naturforscher und Aerzte," or to Mr. Dreyfus, 44, Frankfurterstrasse, Wiesbaden, where also further particulars can be obtained.

Dr. E. M. Crookshank exhibited a series of cultivations of micro-organisms, and called attention to the somewhat unusual circumstance of being able to show such a typical series all growing at the same time. Many of the kinds exhibited were by this time tolerably familiar to those who were interested in such subjects; but there were one or two of more particular interest about which he would say a few words. He had sometimes drawn attention to the fact that the chromogenic bacteria generally develope their colour only on the surface of the gelatin, but a specimen now shown formed an exception to this rule. It was interesting as being the first *Spirillum* which had been cultivated artificially, and being a chromogenic *Spirillum* had developed its colour in the depths of the gelatin contrary to the general rule. Another specimen was that of *Bacillus figurans*, seen growing upon the surface of the gelatin. When first described, some persons were sceptical as to the fact of a *Bacillus* developing such a symmetrical pattern; but it could now be cultivated quite easily, and he should be happy to supply any one interested in the matter with material from which it could be grown as symmetrically as in the example before them. He also showed a micro-organism which had been said to cause the swine fever—or rather, the swine erysipelas—in Germany. It was to be noted that in Germany there had been many cases of swine disease, and that a different organism had been found associated with it there from the one found here and recognised as the cause of Dr. Klein's swine fever. So far as he (Dr. Crookshank) had been able to make out, they were not identical, the German form being an extremely minute *Bacillus* forming only a cloudy appearance, and seeming to be similar to mouse septicæmia. He thought there was good ground for regarding the two diseases as distinct from each other, the German form being swine erysipelas as distinct from swine fever. He also exhibited an example of a *Bacillus* obtained from putrid fish, which caused the remarkable phosphorescence frequently noticed when fish was decaying.

The President complimented Dr. Crookshank on the remarkable series which he had exhibited, illustrative of a department which he had made so much his own.

Mr. Freeman exhibited a number of series-sections of the anatomy of spiders, worms, &c., which had been made by Mr. Underhill, of Oxford. They were rather remarkable specimens of section-cutting and mounting, in some instances from 30 to 60 consecutive sections having been obtained from the same spider. Some drawings taken from the slides were also exhibited.

The President, referring to a drawing of a longitudinal section through a spider, showing all the organs *in situ*, asked if the section from which this was taken was included in the series exhibited?

Mr. Freeman said that this drawing was not taken from any one section, but was a composite drawing intended to show the internal structure as revealed by the examination of a great number of sections.

Mr. Eve said that though bringing microscopic sections to the Society seemed like "carrying coals to Newcastle," he had ventured to bring some specimens of *Actinomyces* from the jaw of an ox, with a specimen from the Royal College of Surgeons' Museum of the jaw showing what the disease was. The effect upon the animal was to produce tumours in the jaw, and the disease occasionally spread so as to affect the kidneys, intestines, and other parts of the body. The organism consisted of a number of spheres, each having a structureless centre, round which large numbers of *Actinomyces* were arranged very much in the same way as pins might be stuck on a round pin-cushion. The inflammatory new formation was very much like what occurred in the growth of tubercle or syphilis. The disease could be communicated by inoculation to other cattle, and also in the same way from man to the rabbit. The sections were prepared by staining first with a magenta solution, which selected the micro-organisms, and afterwards with a watery solution of methyl-blue, which stained the tissues.

Dr. Crookshank said, with regard to the disease referred to as existing in man, his own view was that there was very little ground for supposing it to be the same as that of the ox. The bovine disease was very clearly marked, and could hardly be mistaken; but he might say that although clinically the two forms of disease might appear very much the same, the fungus which had been found in man differed very materially in its microscopic features from that obtained from diseased cattle. The new method of staining these objects with magenta picric acid would be found very effective; he had tried a great number with success by using orcin and then gentian violet.

Mr. Crisp read a circular which had been sent descriptive of a new glycerin-immersion objective, in which he said were crowded as many optical and other errors as could well be compressed into the space. (*Supra*, p. 645.)

Prof. Rupert Jones and Mr. C. D. Sherborn's paper, "Remarks on the Foraminifera, with especial reference to their Variability of Form illustrated by the Cristellarians, Part II.," was read. (*Supra*, p. 545.)

Mr. G. Massee gave a résumé of his paper "On the Genus *Lycoperdon*," illustrating the subject by drawings upon the blackboard. (*Post.*)

Prof. Bell said that the Fellows of the Society would probably remember that in the course of last winter he took the opportunity of describing what he had been able to observe in the case of some diseased grouse which had been sent to him for examination. Within the last few weeks the disease, whatever it might be, had been killing grouse in considerable numbers on the moors in the south-west of Scotland, though it did not appear to prevail to any great extent elsewhere. In the month of May last he received some of these diseased grouse in fairly good condition, and he examined them very carefully to see if he could discover any cause of death, because on the former occasion the tape-worms were all that could be found, and these did not seem sufficient to cause death by themselves. The first grouse which he examined this year were fairly well nourished, and again the tape-worms were found; he looked carefully, as before, for the small round-worm (*Strongylus*) mentioned by Dr. Cobbold, and again he found it to be absent. In this case, however, he found the intestines were inflamed and gorged with blood; not finding anything further, he wrote to say that they should be examined by a pathologist rather than by a helminthologist. More recently he had received from Sir

William Wallace a grouse which was in a most emaciated condition, there being hardly anything of it but skin and bone. He examined this, and again found tape-worms, and also Dr. Cobbold's *Strongylus.* This being so, they had now three sets of grouse which had died from disease; but the only actual fact before them was that the grouse were dead. In the case of the first, though there were tape-worms, there was no evidence that they were the cause of death. In the second case, the birds had died from inflammation of the intestines, the cause of which was not quite clear; and, in the third case, they died of *Strongylus.* It would therefore appear that what was called "grouse disease" must be either more than one disease, or it must be a disease which would kill the victim in different stages. He was himself disposed to think that there was more than one cause of disease; but up to that time there was no diagnostic sign internally to show conclusively what those causes were. The gamekeepers were a class who were properly supposed to know a great deal about natural history, and they said there were certain outward signs which were sure indications that birds were affected by the disease—they were, however, not comparative anatomists, and perhaps their science generally was to be received with some reserve. Taking as an instance the case of the ptarmigan, a species closely allied to the grouse, it was found that in winter it had a very large number of feathers upon its feet; but as the spring advanced it lost many of these in a natural way. The gamekeepers said that losing the feathers from the feet was a sure sign that the bird was diseased; but as all kinds of grouse more or less lost these feathers about that time of year, this indication of disease fell to the ground, and it had to be admitted that there really was no definition of grouse disease which was acceptable either to the pathologist or to the helminthologist. The action of 'Land and Water,' in proposing to send diseased grouse to M. Pasteur for examination, had caused great excitement in some quarters, but he would venture to say that, as it was impossible to keep these wild birds healthy in confinement for any length of time (after undergoing the journey from Scotland to Paris) the conditions would not be favourable for the formation of an opinion of great value. What he suggested to the owners of moors was that some professed bacteriologist should proceed to the affected districts and examine the matter on the spot—at their expense, not at his own.

The President said that the Fellows would probably remember Prof. Bell's remarks upon the subject last winter, and his exhibition of the actual tape-worms which he had then found. They would not fail, therefore, to be much interested by his additional very practical and interesting series of remarks.

Mr. J. G. Grenfell's paper "On New Species of *Scyphidia* and *Dinophysis*" was read (*supra*, p. 558).

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Bulbochæte gigantea* in fruit.

Mr. Crisp:—Hooke Microscope.

Dr. Crookshank:—Series of Cultivations of Micro-organisms.

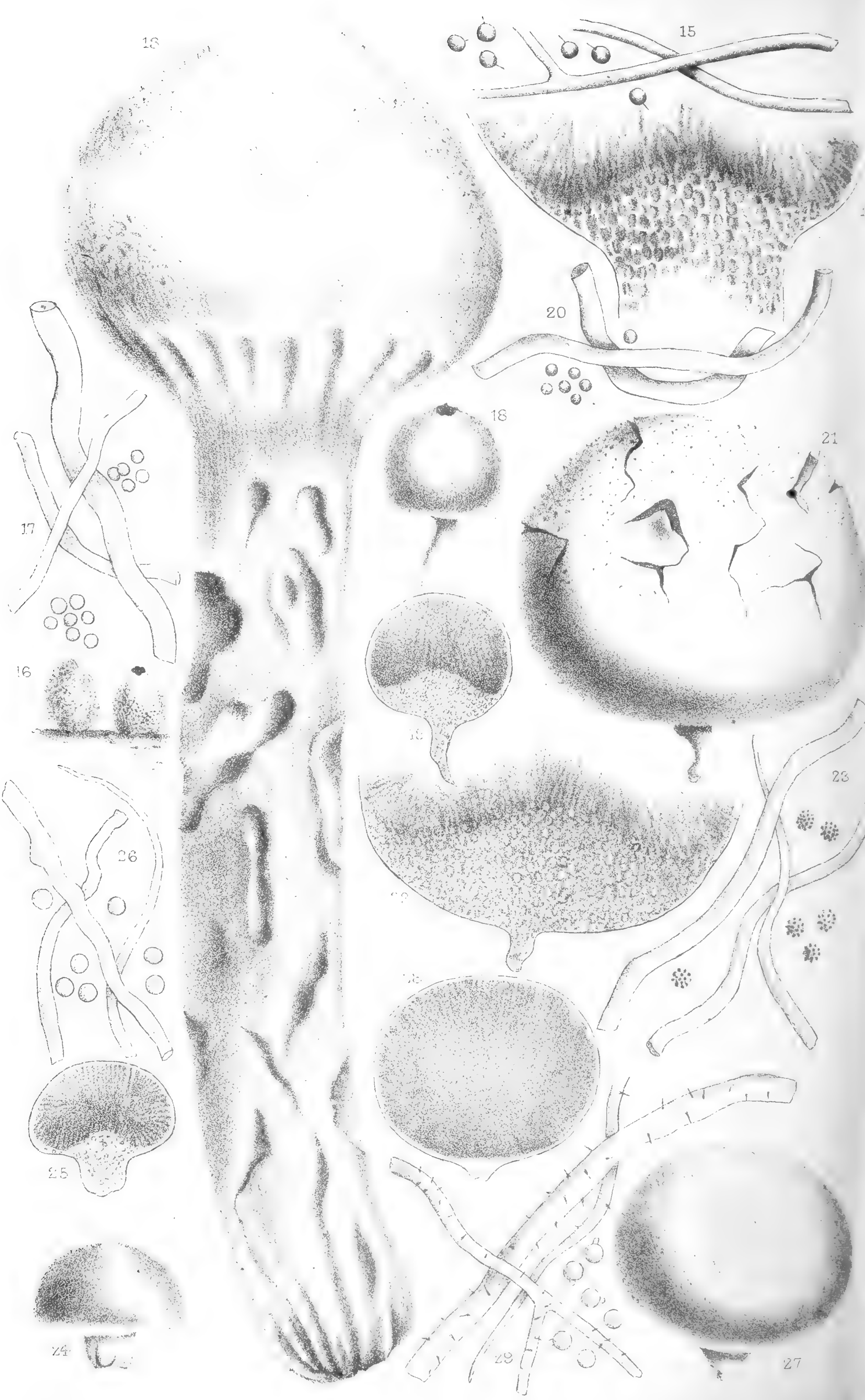
Mr. Eve:—*Actinomyces* from jaw of ox.

Mr. Freeman:—Series-sections of the anatomy of spiders, worms, &c.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. William Ball, Henry F. Dale, and George Day.

G. Massee, del.

West, Newman & Co. lith.



G. Massee, del.

West, Newman & Co. lith.

// JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1887.

TRANSACTIONS OF THE SOCIETY.

XII.—*A Monograph of the Genus Lycoperdon (Tournef.) Fr.*

By G. Massee, F.R.M.S.

(*Read 8th June*, 1887.)

Plates XII. and XIII.

The earliest systematic account of the genus *Lycoperdon* is contained in Fries' 'Systema Mycologicum,' published in 1829, where nine species are described, including *L. Brasiliense* Fr., the only extra-European species then known. Afterwards (1841) Vittadini published his 'Monographia Lycoperdineorum,' in which sixteen species, all European, are described. Of these, two have been removed to the allied genus *Bovista*. During the past forty years, botanical research in every quarter of the globe has added over one hundred additional species, the Rev. M. J. Berkeley alone,

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EXPLANATION OF PLATES XII. and XIII.

Fig. 1.—*Lycoperdon Colensoi* Cke. & Mass.; nat. size.
„ 2.—Section of base of same; nat. size.
„ 3.—Spores and threads of same; × 400.
„ 4.—*L. Capense* Cke. & Mass.; nat. size.
„ 5.—Spores and threads of same; × 400.
„ 6.—*L. Berkeleyi* Mass.; nat. size.
„ 7.—Spores of same; × 400.
„ 8.—*L. oblongisporum* Berk. & Curt.; nat. size.
„ 9.—Spores and thread of same; × 400.
„ 10.—*L. stellatum* Cke. & Mass.; nat. size.
„ 11.—Vertical section of same; nat. size.
„ 12.—Spores and threads of same; × 400.
„ 13.—*L. elatum* Mass.; nat. size.
„ 14.—Section of base of peridium of same; nat. size.
„ 15.—Spores and threads of same; × 400.
„ 16.—*L. calyptræforme* Berk.; nat. size.
„ 17.—Spores and threads of same; × 400.
„ 18.—*L. Natalense* Cke. & Mass.; nat. size.
„ 19.—Section of same; nat. size.
„ 20.—Spores and threads of same; × 400.
„ 21.—*L. violascens* Cke. & Mass.; nat. size.
„ 22.—Section of base of same; nat. size.
„ 23.—Spores and threads of same; × 400.
„ 24.—*L. Cookei* Mass.; nat. size.
„ 25.—Section of same; nat. size.
„ 26.—Spores and threads of same; × 400.
„ 27.—*L. flavum* Mass.; nat. size.
„ 28.—Section of same; nat. size.
„ 29.—Spores and threads of same; × 400.

or jointly with other authors, having described forty-four new forms. The present paper contains descriptions of one hundred and twenty-nine species, forty-nine of which are European, if Bonorden's imperfectly described species are included.

The genus is cosmopolitan, extending from Disco Island, 70° N. lat., to the extreme south of New Zealand, 47° S. lat. It occurs in all lowland tropics, and ascends the Himalayas to between seven and eight thousand feet, where *L. gemmatum* Batsch, a common British species, was collected by Dr. (now Sir Joseph) Hooker. Eighty-five species are confined to the northern hemisphere, twenty-seven to the southern, and fifteen are common to both. Ten species are peculiar to Cuba, and seven to Ceylon. *L. pusillum* Batsch, a common British species about the size of a marble, is represented in the Royal Herbarium, Kew, from Europe, Tropical and South Africa, Lower Pegu, East Nepaul, China, Java, Ceylon, Bonin Islands, North America, South America, Australia, and New Zealand.

The species vary much in colour, shape, and surface texture at different ages, being usually white, and warted or spinose when young, becoming brownish or silvery with age, and frequently perfectly smooth, owing to the falling away of the "cortex"; hence the difficulty, in the absence of type specimens or figures, of ascertaining exactly what species correspond to the meagre descriptions, drawn up almost entirely from external characters, by the pioneers of mycology, who in many instances have given different names to the same species at various stages of growth. Vittadini was the first to employ microscopic along with external characters in the discrimination of species, and he appears to have considered that when once the structure had been worked out, external characters alone were sufficient for the recognition of the species, as three specimens sent to the Rev. M. J. Berkeley as *L. defossum* Vitt., and which externally presented no differences, proved on microscopic examination to be three distinct species: one the true plant intended, another with coarsely warted spores, and the third imperfect, but with a well-developed sterile basal stratum, and smooth spores almost twice the size of those in the species intended.

The spores are supported on pedicels or sterigmata springing from basidia, and in some species the pedicels break away from the basidia and remain attached to the spores, a character considered by Peck, in his arrangement of the United States species of *Lycoperdon*, as being of primary importance; but the examination of a large series of specimens proves this character to be of little or no value, the persistence of the pedicels depending entirely on the relative development of the specimen when collected, and in almost every instance where the plants have been for many years in the herbarium, the pedicels have broken away. The spores are very constant in size, shape, surface marking, and colour, but the last character is only of specific value when the plant is quite ripe, and the spores readily fall out of the ruptured peridium, as in almost every instance they are at first some shade of yellow, and only attain the darker tints when ripe. The colour characters used in the present work refer to the tint of spores in the mass when thrown down on a white surface.

The threads of the capillitium afford good specific characters, depending on the mode of branching; their consistency, whether firm or collapsing when dry; and their thickness compared with the diameter of the spores. The colour of the capillitium is usually some shade of yellow or brown when the spores are thoroughly blown away.

The relative development of the sterile basal stratum varies much in different species, being frequently continued downwards into a more or less elongated stem-like base.

The species are arranged under the following groups:—

A. Sterile basal stratum, well developed, cellular or compact.

- I. Spores globose, rough, purple, lilac, or various shades of brown.
- II. Spores globose, rough, brownish olive, olive, or various shades of yellow.
- III. Spores globose, smooth, purple, lilac, or various shades of brown.
- IV. Spores globose, smooth, brownish olive, olive, or various shades of yellow.
- V. Spores elliptical or subglobose.

B. Sterile basal stratum, rudimentary or obsolete.

- I. Spores globose, rough, purple, lilac, or various shades of brown.
- II. Spores globose, rough, brownish olive, olive, or various shades of yellow.
- III. Spores globose, smooth, purple, lilac, or various shades of brown.
- IV. Spores globose, smooth, brownish olive, olive, or various shades of yellow.
- V. Spores elliptical or subglobose.

In attempting to unravel the synonymy of the old authors, it must be distinctly understood that references to figures only implies that they externally resemble the species under which they are placed, and it has already been shown that external characters alone are of little value.

I take this opportunity of acknowledging my great indebtedness, and also of tendering my best thanks, to Dr. M. C. Cooke for the valuable assistance rendered during the preparation of this paper.

Lycoperdon (Tournef.), Fries, Syst. Myc., iii. p. 27.—Peridium membranaceous, single, the subpersistent cortex becoming broken up into warts or spines, dehiscing by a small apical mouth, or the whole of the upper part evanescent. Capillitium dense, springing from the more or less developed sterile basal stratum; spores globose or elliptic, externally rough or smooth.

The genus was founded by Tournefort,* who included under it a heterogeneous assemblage of Trichogastres, Fries being the first to use it

* Inst. R. Herb., p. 563.

in the restricted sense as defined here. *Bovista* differs in having the capillitium springing from every part of the peridium, in the more compact nature of the cortex, and in the entire absence of a sterile basal stratum. The last-mentioned character, along with the thick corky peridium, separates *Scleroderma*. *Tulostoma* differs in having the peridium distinct from the stem, and *Hippoperdon* in the labyrinthiform arrangement of the capillitium, which is adnate to the peridium on all sides.

A. *Sterile basal stratum well developed, cellular or compact.*

I. *Spores globose, rough, purple, lilac, or various shades of brown.*

1. *L. Hoylei*, B. & Br., Ann. Nat. Hist., No. 1037.—Peridium stipitate, subglobose, densely covered with long purple-brown stout spines, stem stout, spinulose, inner substance bright olive, root of long white fibres. Capillitium dense, thickest threads wider than diameter of spores, sparsely branched, passing into the compact sterile portion; spores bright lilac, globose, warted, 5 μ, often furnished with a long hyaline pedicel.

Stem from 1/2 to 1 in. long, 3/4 in. thick; peridium, 2 in. diam.

Resembling *L. echinatum* in general appearance, differing in the presence of a stem, the colour and size of the spores, and in the very compact non-cellular sterile stratum.

England (Reading). Oct.

2. *L. echinatum*, Pers. Symb. Myc., p. 36.—Peridium obovate, covered with long stout purple-brown spines, between which are minute mealy warts of the same colour, root consisting of long white fibres. Capillitium purple-umber, dense, persistent, barren basal portion well developed, cellular, pale ochre, threads about equal to diameter of spores, much branched; spores purple-umber, spherical, strongly warted, 6 μ diam.—Pers. Syn., 147. *L. gemmatum* γ *echinatum*, Fr. G. M., iii. p. 37. *Utraria echinata*, Quel. Champ. Jur. et Vosg., ii. t. 3. Rabenh. Krypt. Fl., figs. 1–2, p. 894.

The spines are often curved, and when they have fallen away, the peridium presents a tesselated appearance, due to the pale scars being surrounded by the small persistent dark warts.

From 1/2–1½ in. diam. In woods amongst leaves, generally solitary. Autumn. Europe.

It is doubtful what species Peck has in view under the name of *L. echinatum* Pers., in U.S. Sp. Lycop., as he considers a distinguishing feature to be the *smooth surface* of the peridium after the spines have fallen off. It cannot be the true *echinatum* of Persoon.

3. *L. constellatum*, Fr. Syst. Myc., iii. 39.—Subglobose, or subturbinate and tapering towards the base, peridium membranaceous, persistent, clothed with stout, spreading reddish-brown spines; between the spines are minute warts of the same colour, which remain after the spines fall off, and form a reticulated pattern. Capillitium lax, threads firm, variable in thickness, branched, axils rounded, tapering, bright brown by transmitted light, sterile base cellular; spores purple-brown, globose, warted, sometimes stipitate, 5–6 μ diam.—*L. umbrinum*, Fl. Dan., MDCCC. Peck, N.Y. Nat. Hist. Mus. Bot. Report (29th), pl. 2, f. 13–14.

Related to *L. echinatum* and *L. Hoylei;* distinguished from the former by the much weaker spines and rounded axils of the branching threads, and from the latter by the absence of a true stem.

On the ground, amongst leaves. Europe, United States.

4. *L. pulcherrimum*, B. & C., Grev., ii. p. 51.—Broadly obovate, bristling with crowded whitish, stout, elongated pyramidal spines with minute warts between, base smooth and plicate. Capillitium dense, threads usually thicker than diameter of spores, firm, branched, tapering, sterile base cellular, well developed; spores brownish purple, globose, very minutely warted, usually pedicellate, 5 μ diam.

About 1 in. in diam. On the ground. Pennsylvania.

In the original description of this species, the spores are described as being *smooth* and *olive.* The specimens received by Berkeley, and from which the specific character was drawn up, are still in that gentleman's herbarium in excellent preservation, and are one of the many examples met with, in going over the specimens, of a change in colour, always verging on purple, having taken place in the spores after drying. The very minute warts may possibly have been overlooked in the first instance. As the spines on the peridium become old and dry, they have a tendency to split up in a fibrillose manner from the base.

5. *L. Frostii*, Pk. U.S. Sp. Lycop., p. 17.—Peridium subglobose, 1–2 in. broad, generally narrowed into a short stem-like base, echinate or shaggy, with long, stout, whitish spines, which are generally curved or stellately united, and which at length fall off and leave the peridium brown and smooth. Capillitium and spores purplish brown; spores rough, 0·00016–0·0002 in. (= about 5 μ) in diam.

Said to differ from *L. constellatum* in its longer paler spines, and in having the denuded peridium smooth.

In the absence of specimens it is impossible to say with certainty, but I strongly suspect that this species is the same as *L. pulcherrimum* B. & C. See notes under last-mentioned species.

Ground in meadows. United States.

6. *L. hirtum*, Mart. Crypt. Erl., p. 386.—Broadly turbinate, contracted into a rather thick root; peridium thin, persistent, densely covered with soft slender spines, which fall away, leaving a smooth, non-reticulated surface, reddish umber, mouth small. Capillitium dense, threads firm, thickness variable, tapering, branched, axils rounded, sterile base well developed, slightly cellular; spores brownish purple, globose, minutely warted, 5 μ.—*L. umbrinum* γ *hirtum*, Pers. Syn., 147–148 (*non Bon.*). *Utraria hirta*, Quel. Jur. et Vosg., 358.

From $1\frac{1}{2}$–2 in. high. On the ground. Europe.

7. *L. atropurpureum*, Vitt. Lycop., 186.—Peridium thin, flaccid, subglobose or pyriform, stipitate or sessile, base more or less plicate, with slender spinules, becoming glabrous above, dehiscing by a minute irregular mouth, brownish above, becoming paler downwards, spinules darker. Capillitium continuous with the well-developed cellular sterile base; spores blackish purple, spherical, warted, sometimes pedicellate, 6–7 μ diam.—Vitt., t. 2, f. 6. *L. esculentum*, &c., Mich. Gen., t. 97, f. 4. *L. quercinum*, Pers. Syn., pp. 147–8. *L. atropurpureum*, Sci. Gossip, Dec. 1866. Cke. Hdbk., 1085.

Size variable, from $1–2\frac{1}{2}$ in. across. In oak woods, &c. Autumn. Europe, United States.

8. *L. velatum*, Vitt. Lycop., p. 187.—Peridium subglobose or turbinate, umbonate, with a rooting base, flaccid, cortex at first continuous, white then pallid, becoming broken up into irregular adnate patches with fibrillose margins, between the patches ochraceous with minute persistent warts, dehiscing by a minute aperture. Capillitium dense, floccose, threads rarely branched, thicker than diameter of spores, tapering, continuous with the compact minutely cellular sterile base; spores olive, then brownish purple, spherical, warted, sometimes pedicellate, 4–5 μ diam.—Vitt. Lycop., t. 2, fig. 3. *L. album*, &c., Mich. Gen., t. 97, f. 2. *L. mammæforme*, Pers. Syn., 145. *L. lanatum*, Batsch, Elench., p. 147. *Utraria velata*, Quel. Champ. Jur. et Vosg., 358.

From 1 to 2 in. diam. In oak woods. Autumn. Italy, France.

9. *L. cyathiforme*, Bosc., in Berlin Mag., lxxxvii., t. 6, f. 11.—Subglobose, peridium thick, cortex mealy, becoming broken up into angular adnate patches, root stout, elongated. Threads of capillitium rather thinner than diameter of spores, lax, branching, axils acute, tapering, sterile base cellular; spores brownish purple, globose, strongly warted, often pedicellate, 8 μ diam.—Ravenel, Fungi Carol. Exs., No. 4.

Rather more than 1 in. across. On the ground, in sandy places in pine woods. Europe, Somerset East, South Africa, North America.

10. *L. lilacinum* (Berk.) Mass.—Broadly obovate or turbinate, and contracted into a stout cellular stem-like base. Peridium thin and evanescent above, dehiscing by a large irregular opening, cortex white, polished, breaking away in papery patches. Threads of capillitium thinner than diameter of spores, flaccid, simple, continuous with the convex cellular sterile basal stratum; spores violet, with a tinge of ochre, echinulate, globose, 6 μ.—*Bovista lilacina*, Berk. & Mont., Hook. Lond. Journ., 1845.

From 2–4 in. high, and 2–3 in. broad. On the ground. Australia, Tasmania, Ceylon, Madras.

11. *L. violascens* Cke. & Mass., nov. sp.—Globose, sessile, sometimes rather plicate below, and terminating in a short slender root. Peridium papyraceous, persistent, at first covered with minute granular warts, becoming smooth and shining, persistently white, dehiscing above by a large irregular opening. Threads of capillitium variable in thickness, often nodulose, tapering, free from the large, convex, cellular sterile base; spores lilac, globose, minutely warted, 6 μ. Plate XIII. figs. 21–23.

About $1\frac{1}{2}$ in. across. On the ground. Australia.

12. *L. Curreyi* Mass.—Globoso-depressed passing into a short thick stem, or subturbinate, with a long thick root, peridium papyraceous, fragile, almost smooth, the upper part breaking away in patches, leaving a cup-shaped opening with an irregular margin. Threads of capillitium thin, rarely branched, colourless by transmitted light, sterile base well developed, cellular; spores violet, globose, minutely warted, 6 μ in diam. —*L. radicatum*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 289, tab. 20, figs. 8–9 (1868). There is a *L. radicatum* D. R. & Mont. of slightly prior date.

3–4 in. high, 2–4 in. broad. In grassy places amongst bushes. Loanda, West Africa, Cape of Good Hope.

13. *L. fucatum*, Lev. Ann. Sci. Nat., 1844, 219.—Sessile, subglobose, glabrous, white. Capillitium continuous with the cellular sterile base, threads firm, thin, flexuous, frequently branched, axils rounded; spores dark lilac, becoming vinous brown, globose, strongly echinulate, 5 μ.—Lev. in Voy. Bonite, t. 140, f. 3.

From 1–2 in. diam. On the ground and on old trees, &c. Monte Video, New Mexico, East Nepal, Ceylon.

14. *L. fragile*, Vitt. Mon., p. 180.—Peridium thin, very fragile, evanescent above, subglobose or pyriform, more or less plicate below, irregularly rooting, minutely warted or subtomentose, becoming almost glabrous from ochraceo-cinereous to brownish purple. Capillitium continuous with the subcompact floccose basal sterile portion; spores passing from bright ochre to blackish purple, globose, minutely warted, 5 μ diam. —*L. bovista*, Vitt. Mang., t. 3, f. 2.

Vittadini says that it varies in size from a walnut to that of the closed hand. When old the capillitium disappears, and the peridium stands up like a cup, with the margin irregularly laciniated.

Grassy places. Summer and autumn. Italy, Algeria.

15. *L. Caffrorum*, K. & C., Grev., x. p. 109 (1882).—Peridium turbinato-globose, 2–3 in. diam., base attenuated, rooting, at first almost smooth, then broken up into minute scales, ferruginous brown. Capillitium continuous with the sterile base; spores echinulate, brownish.

Somewhat resembling *L. Gardneri* B., but smaller, deeper coloured, and spores not so rough.

Somerset East, South Africa.

16. *L. glabellum* Peck, N.Y. Nat. Hist. Mus. Bot. Report (31st), p. 39.—Subglobose or turbinate, sometimes narrowed below into a short stem-like base, yellow or brownish yellow, furfuraceous with minute nearly uniform persistent warts; capillitium and spores purplish brown, columella present; spores rough, 0·0002–0·00025 in. diam. (= about 6 μ).—U.S. Sp. Lycop., p. 20.

From 2/3 to 1½ in. in diam. Ground in pine woods and bushy places. United States, Somerset East, South Africa.

17. *L. asterospermum*, D. R. & Mont., Fl. Algér., 379.—Peridium obovate-pyriform, dirty rufous, rather rigid above, flaccid below, covered with minute crowded spinose warts; dehiscing by a well-defined small circular mouth; root long, tapering. Capillitium continuous with the yellowish floccose minutely cellular sterile base, threads often nodulose, branched, axils acute, varying in thickness, tapering; spores brownish purple, globose, warted, 7 μ diam.

Externally resembling *L. pyriforme*, about 1 in. across. In sandy woods. Algeria.

18. *L. decipiens*, D. R. & M., Fl. Alg., 380.—Peridium membranaceous, flaccid, obovate at first with spinulose warts, becoming smooth, dark grey and shining, dehiscing by a small lacerated orifice, root tapering. Capillitium continuous with the copious very cellular sterile stratum; threads branched, axils rounded, thinner than diameter of spores, often verrucose, tapering; spores purple-umber, globose, warted, 6 μ diam.

About 3/4 in. diam. On the ground. Algeria.

19. *L. cupricum*, Bon. Bot. Ztg., 1857, 625.—Peridium obconic, depressed, plicate below, tapering to an acuminate rooting base, at first greyish flesh colour, then coppery, becoming umbonate, and dehiscing by a small laciniate mouth. Spores purple-umber, spinulose.

In shady woods. Germany.

20. *L. elongatum*, Berk. Hook. Journ., vi. (1854) 171.—Stipitate; peridium obovate, minutely verrucose, dehiscing by a large opening, stem long, thick, tapering downwards. Threads of capillitium flexuous, branching at wide angles, axils acute, sterile portion cellular; spores umber, globose, strongly echinulate, 6 μ diam.

Stem 2 in. high, 3/4 in. thick above. On the ground, amongst moss. Nepaul and Sikkim Himalayas.

II. *Spores globose, rough, brownish olive, olive, or various shades of yellow.*

21. *L. saccatum*, Vahl. Fl. Dan., t. 1139.—Stipitate, spherico-depressed, obtuse, above with small spinulose warts becoming smaller and fibrillose below and on the stem, dehiscing by an irregular aperture; stem stout, more or less elongated, nearly equal, often more or less lacunose, cellular within. Capillitium compact, persistent, threads branched, axils not rounded, thinner than diameter of spores; sterile basal portion convex, cellular; spores olivaceous umber, strongly echinulate, spherical, 6 μ diam.—Fr. Syst. Myc., iii. 35. Cke., Fung. Brit. Excs., No. 214. Price, pl. 3, f. 14. Hussey, i. pl. 26. Sci.-Gossip, Dec. 1866. Cke. Hdbk., 1087. Krombh., t. 30, f. 11–12. *Utraria saccata*, Quel. Champ. Jur. et Vosg., 361.

Peridium 1–2 in. in diam., stem 2–3 in. long, 1 in. or more thick. In thickets and open woods, amongst moss. Europe, North America, Somerset East, South Africa.

22. *L. excipuliforme* Scop. — Peridium subglobose or depressed, passing into a stout stem, at first with spinose warts which partly disappear leaving the surface tomentose, stem rather plicate at the base. Threads of capillitium flexuous, rarely branched, continuous with the sterile cellular base; spores globose, dirty olive, minutely warted, 4–5 μ diam.—Vitt. Lyc., 193. Schaeff. Ic., t. 187. Bull., t. 450 and t. 475? Paulet, p. 121, t. cci. f. 6. Karst. Myc. Fenn., p. 362. Nees, Pilze, t. 11, f. 126. Sverig. Svamp., pl. lxxiii. Pers. Syn., 143. Pabst, Crypt. Fl., t. 23. *L. gemmatum* γ *excipuliforme*, Fr. S. M. iii. 37. *Utraria excipuliforme*, Quel. Champ. Jur. et Vosg., 360. *L. excipuliforme*, Vitt. Lyc., 193.

Variable in size, from 1–4 in. high. In woods and meadows. Europe.

23. *L. cinereum*, Bon. Bot. Ztg. 1857, 615.—Peridium capitate, umbonate, narrowed downwards into a stem-like base, at first livid-grey, verrucoso-floccose, becoming smooth and obscure brown. Spores globose, spinulose, olive.

In woods. Europe.

III. *Spores globose, smooth, purple, lilac, or various shades of brown.*

24. *L. marginatum*, Vitt. Lyc., 185. — Turbinate or broadly obconic, obtuse, bristling with various sized pyramidal spines becoming smaller downwards and eventually disappearing above, permanent below and defined by a marginate line; dehiscing by a small apical aperture; root elongated tapering. Capillitium continuous with the prominent convex cellular sterile base, and forming an imperfect columella, threads firm, rarely branched, mostly thicker than diameter of spores, tapering; spores purple-brown, smooth, globose, sometimes pedicellate, 5 μ diam. —Vitt. Lycop., t. 1, f. xi. *L. echini*, &c., Batt., t. 31, f. C. *L. papillatum?* Schaeff., t. 184.

An inch or more across. In sterile sandy places. Europe, Algeria.

25. *L. Natalense* Cke. & Mass., nov. sp.—Globose, sessile, passing abruptly into a short tapering root; peridium thick, minutely warted becoming smooth, mouth small, irregularly torn. Capillitium dense, free from the well-developed, convex, cellular sterile base, threads very thick, firm, flexuous, simple; spores olive with a tinge of purple, globose, smooth, 3 μ diam. Plate XIII. figs. 18–20.

From 1/2–2/3 in. diam. Ochraceous. On the ground. Quanda, Natal.

26. *L. bicolor*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 290, t. 20, f. 12.—Stipitate $1\frac{1}{2}$–2 in. high, stem white, subcylindrical, attenuated towards the base; peridium brownish lead colour, papyraceous; capillitium brown; spores brown, globose, smooth, 5–6 μ diam.

In moist open places in woods. West Africa.

27. *L. æstivale*, Bon. Bot. Ztg., 1857, p. 630.—Peridium globose, granuloso-floccose, papyraceous, dehiscing by an irregularly toothed orifice, white, then brownish or greyish ochre; stem very short, stout, passing into the fusiform root. Capillitium fugacious, threads about equal to diameter of spores; sterile basal portion cellular, well developed; spores dark umber, globose, smooth, 6 μ diam.

Pileus 1/2 in. or more diam. Grassy places. August. Europe.

28. *L. rubecula*, B. & Br., Fungi Ceylon, No. 720, Journ. Linn. Soc., xiv. p. 80.—Peridium whitish, glabrous downwards, above with very minute rufous warts, conico-turbinate passing into the thick stem, which is more or less rugose at the base. Capillitium ochraceous, sterile portion well developed, spores ochraceous brown, globose, smooth, 3–4 μ diam.

On the ground. Ceylon.

Peridium with stem 2/3–1 in. high. When dry altogether dirty ochraceous red, paler below. Mycelium fibrillose, white. In one of the types in Herb. Berk. the spores have a lilac tinge, and possibly they may be purplish when old.

29. *L. sericellum*, Berk., in Hook. Journ., 171.—Subglobose, obtuse, passing into a stout stem, silky or velvety, dehiscing by an apical aperture. Capillitium very dense, continuous with the compact silky sterile stratum, threads about equal in thickness to diameter of spores, branched, often nodulose; spores cinnamon, smooth, globose, 4 μ diam.

Peridium from 2 to 3 in. diam. On the ground. Darjeeling, India.

IV. *Spores smooth, globose, brownish olive, olive, or various shades of yellow.*

30. *L. elatum* Mass., nov. sp.—Stipitate, peridium globose, subumbonate, thin, with a few evanescent furfuraceous squamules, lacunose below; stem elongated, equal, cellular, lacunose. Capillitium dense, persistent, continuous with the copious cellular base, threads lax, thinner than diameter of spores, sparingly branched, firm; spores ferruginous-olive, globose, smooth, shortly pedicellate, 5 μ diam. Plate XIII. figs. 13–15.

In Herb. Berk. placed with *L. saccatum*, probably without examination. Allied to *L. perlatum*.

Peridium 2 in. across, stem 6 in. long, 2/3 in. thick, reddish ochre when dry. On the ground. New England.

31. *L. perlatum*, Pers. Syn., p. 145.—Peridium variable, subglobose with an elongated stem, subglobose or depressed and nearly sessile, umbonate, ochraceous or dirty brown, at first covered with spinose warts, which are smaller downwards, disappearing with age, mouth small, torn, at apex of umbo. Capillitium continuous with the convex cellular sterile base and forming a columella, threads rarely branched, about equal in thickness to diameter of spores, flexuous; spores olivaceous, globose, smooth, 4 μ diam.—*L. perlatum*, Barla, pl. 46, f. 8. *L. gemmatum*, Fr. S. M., iii. 36. Sverig. Svamp., tab. lxxiii. Fl. Dan., MCXL. Krombh., t. 30, f. 6. Cke. Hdbk., 1088 (including *L. gemmatum*). Palist, Crypt. Fl., t. 23. *L. constellatum*, Sturm, t. 7? *L. lacunosum*, Bull., t. 52? *L. hirtum*, Bull., t. 340? *L. perlatum*, Vitt. Mon., 194. Allied to *L. gemmatum*, but readily distinguished by the umbonate mouth and distinct columella. The peridium is often plicate below, and the stem more or less lacunose. Often occurs in pairs from the same base.

In woods, especially of oak. Summer and autumn. Europe.

32. *L gemmatum*, Batsch, Elench., p. 147.—Stipitate, subglobose, depressed above, or lens shaped, obtuse, with prominent spinose warts of various sizes, which eventually fall off, leaving the surface smooth and shining, dehiscing by a small opening; stem stout, tapering downwards. Capillitium continuous with the well-developed cellular sterile base, threads lax, rarely branching, axils acute, tapering; spores olivaceous umber, globose, smooth, 4 μ diam.—*L. gemmatum*, Hussey, i. pl. 54. Sci. Gossip, Dec. 1866. Eng. Flor., 304 (including *L. perlatum*). Karst. Myc. Fenn., iii. 361 (including *L. perlatum*). Cke. Hdbk., 1088 (including *L. perlatum*). *L. gemmatum β perlatum*, Fr. S. M., iii. 37. *Utraria gemmata*, Quel. Champ. Jur. et Vosg., p. 358.

Peridium 1–2 in. diam. Amongst grass, &c., in woods and shady places.

There is a form in Herb. Berk. from Sikkim Himalayas with the peridium fusiform, in some of the specimens elongated and not much thicker than the stem, but it agrees with the present species in the capillitium and spores, and is connected with the typical form by transitional states from various countries.

Europe, North America, Sikkim Himalayas (7–8000 ft.), Simla,

India, Tihri-Garhwal, N.W. India, Somerset East, South Africa, Algeria, Swan River, Illawarra, Solomon Islands, Tasmania, New Zealand.

33. *L. Berkeleyi* Mass.—Peridium subglobose or slightly depressed, delicate, prunioso-furfuraceous, stem stout, cellular. Threads of capillitium about equal in thickness to diameter of spores, branched, angles acute, free from the cellular base; spores ochraceous with a tinge of pink, smooth, globose, 3 μ diam.—*L. delicatum*, Berk. & Curt., Grev., ii. p. 51. There is a *L. delicatum* Berk. of prior date. Plate XII. figs. 6 and 7.

Peridium about 2½ in. across, cellular stem-like base, 1–1½ in. long and of equal thickness. Pennsylvania.

34. *L. Colensoi* Cke. and Mass., nov. sp.—Subcylindrical, peridium thin collapsing, dehiscing by a small apical torn mouth, above with scattered spinose warts which become smaller, shorter, and more crowded downwards, ochraceous when dry. Capillitium dense, threads thicker than diameter of spores, flaccid, basal sterile stratum well developed, very cellular; spores olivaceous-brown, smooth, globose, 4 μ diam. Sometimes subclavate and plicate at the base. Plate XII. figs. 1–3.

From 1½–2½ in. high, ¾ in. across. On the ground. New Zealand.

35. *L. echinulatum*, B. & Br., Fungi Ceylon, No. 722, Linn. Journ., xiv. p. 80.—Turbinate, passing into a short obconic stem, bristling with rather stout spinose warts, which are largest above. Capillitium continuous with the dense indistinctly cellular sterile base; spores citrin, globose, smooth, 3 μ diam. (= *L. echinellum*, B. & Br., in Herb. Berk.).

From 1–1¼ in. diam. On the ground. Ceylon.

36. *L. pyriforme*, Schaeff. Icon., t. 185.—Pyriform, membranaceous, rather umbonate, dehiscing by a small torn mouth, covered with minute pointed warts, becoming smooth; root of numerous white, long, branching fibres. Threads of capillitium thicker than diameter of spores, branched, continuous with the slightly cellular sterile base forming a columella; spores olive, smooth, globose, 4 μ diam.—*L. pyriforme*, Price, pl. 15. Schaeff., 185. Sci. Gossip, Dec. 1866. Fr. S. M., 3, 38. Hussey, i. pl. lxx. Cooke, Exs., No. 215. Fuckel, Exs., No. 1260. Grev., t. 304. Cke. Hdbk., 1089. Eng. Flor., 304. Karst. Myc. Fenn., iii. 362. Barla, t. 46, f. 10–11. *Utraria pyriformis*, Quel. Jur. et Vosg., 360. *L. ovoideum*, Bull., t. 435, f. 3. *L. pyriforme*, Vitt. Mon., t. 2, f. 9, p. 196.

Generally in clusters. Variable in form and size, from 1–3 in. high. On decaying trunks or on the ground.

Europe, North America, Venezuela, Cuba, Arctic America, Galapagos, Sikkim Himalayas (4–7000 ft.), Bombay, New Guinea, Japan, Tasmania, New Zealand, Australia.

Var. *excipuliforme* Desm.—Cæspitose, subglobose, rufous-umber, rough with very slender warts, with a distinct elongated stem; root of long fibres.—Desmazières, Crypt. France, ser. i., No. 1152.

Differs from type in having a slender stem of equal thickness.

Autumn. France.

37. *L. glabrescens*, Berk. Fl. Tasm., ii. 226.—Subhemispherical,

mouth conical, plicate below, at first covered with slender floccose spines, becoming glabrous; stem short, stout, tinged violet inside. Capillitium dense, continuous with the cellular sterile base, threads firm, about as thick as diameter of spores, often nodulose, branching, axils rounded, tapering; spores dark cinnamon, tinged olive, smooth, globose, often pedicellate, 5–6 μ diam.

Peridium $1\frac{1}{2}$ in. diam. Tasmania, Australia.

38. *L. hiemale*, Bull. Champ., t. 72, figs. B, D, E, and t. 475, fig. E.—Subglobose or broadly turbinate passing into the narrowed base-like stem, flaccid, collapsing, at first covered with prominent pointed warts, becoming smooth, dehiscing by an irregular apical pore, often rooting. Capillitium distinct from the well-developed cellular sterile base, threads firm, variable in thickness, branched, axils rounded; spores olivaceous umber, globose, smooth, 3–4 μ diam.—Vitt. Lycop., 190, t. 2, f. 5; Sacc. Mycotheca Ven., 1103; Sacc. Mycol. Ven., 71; *L. echinatum* Schaeff., t. 186, f. 2; *L. gemmatum*, Schaeff., t. 189, f. 4–5.

In dry grassy places. Summer and autumn. Europe, Algeria.

39. *L. molle*, Pers. Syn., 150.—Turbinate, base broad, abrupt, peridium papyraceous, collapsing, furfuraceous, becoming smooth, dehiscing by a small irregular mouth. Threads of capillitium thicker than diameter of spores, collapsing, sterile base well developed, slightly cellular, marginate, almost distinct from the capillitium; spores ochraceous-olive, globose, smooth, 4 μ diam.

Size of *L. pyriforme*, colour much darker, almost dilute olive, very soft to the touch, root none. Pers.

On the ground in oak woods. Autumn. Germany, France, United States.

40. *L. Curtisii*, Berk. Grev., ii. p. 50.—Subglobose, contracted into a short rooting base, pallid, with dense stout spinose warts, which become smaller downwards. Threads of capillitium twice as thick as diameter of spores, flaccid, sterile stratum large, cellular; spores dirty ochraceous, smooth, globose, 3–4 μ diam.

About 1/3 in. diam.

Connecticut, Upper and Lower Carolina, Somerset East, Africa.

41. *L. leucotrichum*, D. R. & M., Fl. Alg., 383.—Subglobose, base abruptly narrowed, peridium membranaceous, thin, fragile, everywhere covered at first with soft spinose warts, becoming partly smooth, dehiscing by a laciniate orifice. Capillitium white, at length separating from the cellular base, spores smooth, yellowish olive.

Peridium about 1 in. across. In grassy places. Algeria, France.

42. *L. pedicellatum*, Peck, N.Y. Nat. Hist. Mus. Bot. Report (26th), p. 73.—Peridium globose or depressed-globose, sessile or narrowed below into a stem-like base, whitish or cinereous, becoming dingy or smoky brown with age, echinate with rather dense spines, which are either straight or curved or stellately united, and which at length fall off and leave impressions or obscure reticulations on the surface; capillitium and spores greenish yellow, then dingy olive, columella present; spores smooth, pedicellate, 0·00016–0·00018 in. in diameter, the pedicel three to five times as long (= about 4 μ).—U.S. Sp. Lycop., p. 22. "The pedicellate spores constitute the peculiar feature of this species,"

consequently I presume the species could not be recognized from a specimen that had been collected say thirty years. This species is certainly not synonymous with *L. pulcherrimum* B. & C., as stated by Peck.

From 2/3 to $1\frac{1}{2}$ in. diam. Ground and decaying wood in woods and bushy places. United States.

43. *L. Bonordeni* Mass.—Peridium umbonate capitate or obconic, contracted into a short stem-like base, covered with ventricose spines, white then umber, dehiscing by a torn umbonate mouth. Capillitium forming a columella; spores globose, smooth olivaceous, minute.—*L. hirtum*, Bon. Bot. Ztg., 1857, p. 632. *L. hirtum* Mart. has priority.

In woods. Europe.

44. *L. Kakavu* (Zipp.), Lev. Ann. Sci. Nat., 1844, p. 220.—Peridium rotundato-depressed, covered with minute granular warts, plicate below and passing into the furfuraceous obconic cellular stem. Capillitium and lobose smooth spores olive-brown.—*Bovista Kakavu* Zipp. (Herb. Lugd. atav.).

About 1 decimetre high. On the ground. Java.

45. *L. bovista* L., Sp. Pl., 1653.—Peridium spherical or depressed, sessile; cortex thick, fragile and evanescent above, breaking up into polygonal pieces, at first sub-tomentose, then smooth; white, becoming darker. Capillitium compact, continuous with the sterile cellular base; spores dusky olive, globose, smooth, rather variable in size, 5–6 μ diam. In Greville's fig. some of the spores are shown with a pedicel.—*L. bovista*, Vitt. Mon., p. 181. Fr. S. M., iii. 29. Karst. Myc. Fenn., iii. 360. Fr. Sverig. Svamp., lxxii. Bull., 447. Vitt. Lyc., 181. *L. giganteum*, Fl. Dan., MDCCCCXX. Hussey, i. pl. 26. Pabst, Crypt. Flor., t. 23. Cke. Hdbk., 1083. Eng. Flor., 303. Batsch, Elench., p. 238, t. 39, f. 165. Sow., t. 332, upper fig. Corda, Ic., v. f. 40. *Bovista gigantea*, Nees, Pilze, t. xi. f. 124, C. Grev., 336. *L. maximum*, Schaeff. Ic., 191. *Langermannia gigantea*, Sturm, t. 10. *Globularia gigantea*, Quel. Champ. Jur. et Vosg., 362.

Grows to a large size, sometimes a foot or more in diameter. Grassy places. Summer and autumn.

Europe, North America.

46. *L. Fontanesii*, D. R. & Lev., Fl. Alg., 381, t. 22.—Peridium globose or broadly obovate, passing into a narrow strongly plicate base, whitish becoming reddish ochre, thick and leathery, areolate or broken up into soft elongated warts, fragile and breaking away in patches above; root stout, elongated. Capillitium dense, threads thicker than diameter of spores, rarely branched, soon separating from the dense minutely cellular, purple-brown prominent sterile base; spores ferruginous olive, globose, smooth, often pedicellate, 4 μ diam.—*L. complanatum*, Desf. Fl. Atl., p. 435.

Solitary or gregarious, varying in size from an apple to a child's head. In sterile elevated limestone districts.

Algeria, New Zealand.

47. *L. cælatum*, Bull. Champ., t. 430.—Peridium sessile or stipitate, subglobose or depressed, cortex pale creamy ochre, very thin, minutely furfuraceous, breaking away above in areolæ; inner coat thicker, smooth,

ashy grey. Capillitium ochraceous olive, threads frequently branched, axils rounded, thicker than diameter of spores at thickest parts, tapering, evanescent, sterile basal portion well developed, cellular, dense, free from capillitium; spores dirty olive, spherical, smooth, 5 μ diam., frequently furnished with a hyaline pedicel 2–3 times as long as diameter of spore.—*L. cælatum*, Fr. S. M., iii. 32. Vitt. Lyc., 188. Berk. Outl., t. 20, f. 7. Eng. Flor., 303. Krombh., t. 30, f. 7–10. Harzer, t. lxxiv. Schaeff., t. cxc. Nees, Pilze, t. 10, f. 1. Hussey, ii. pl. 23. Cke. Hdbk., 1084. Barla, pl. 46, f. 4. *L. gemmatum*, Schaeff. Ic., t. 189, figs. 1–3. *L. bovista*, Nees, Pilze, t. 11, f. 125. *Bovista officinarum*, Sturm, t. 1. *Utraria cælata*, Quel. Champ. Jur. et Vosg., p. 360.

Very variable in form, generally spherico-depressed and sessile or with a short thick stem, or with a thin stem from 1–2 in. long. Peridium from 1–4 in. in diameter.

Common in fields, woods, roadsides, &c. Autumn.

All Europe, North America, Behring's Straits, Falkland Islands, Cuba, Neelgheries, Darjeeling, Kuram Valley, India, Tasmania, New Zealand, Algeria, Australia.

48. *L. favosum* (Rostk.), Bon. Bot. Ztg., 1857.—Broadly turbinate, depressed, contracted into a more or less plicate short stem-like base, upper part of peridium fragile, evanescent, leaving a wide opening with torn edges, lower portion with polygonal depressions, presenting a honey-comb-like appearance. Capillitium compact, threads branched, sterile cellular base well developed; spores smooth, globose, blackish olive.—*Bovista favosa*, Rostk., in Sturm, t. 3. *L. cælatum*, Barla, pl. 46, f. 5.

2–3 in. across. On the ground. Europe.

49. *L. capense*, Cke. & Mass., nov. sp.—Globose, sessile, minutely furfuraceous becoming smooth, plicate below, with a long stout tapering root. Capillitium dense, threads of uniform thickness, equal in diameter to spores, simple, much interlaced and curled, continuous with the compact basal stratum, spores bright ochre tinged citrin, smooth, globose, 4 μ diam. Plate XII. figs. 4 and 5.

About 2 in. diam. On the ground. Cape of Good Hope.

50. *L. depressum*, Bon. Bot. Ztg., 1857, p. 611.—Obconic, obtuse or lens-shaped passing into a thick stem, base often plicato-sulcate, covered with small spinose warts, becoming granular or furfuraceous. Threads of capillitium lax, collapsing, thickness about equal to diameter of spores, sterile base well developed, cellular; spores olivaceous umber, smooth, globose, 3–4 μ diam.—Oudeman's Fungi Neerlandici Exs., No. 118.

About 1 in. high. On the ground. Europe.

51. *L. calvescens*, B. & C., Grev., ii. p. 50.—Subglobose, springing from a short thick rooting base, peridium thin, at first with subtomentose spinose warts which fall away above, leaving the surface minutely velvety. Threads of capillitium variable in thickness, often contorted, basal stratum cellular, spores dirty dark ochre, globose smooth, 3–4 μ diam.

Connecticut.

52. *L. Cookei*, Mass., in Herb. Kew.—Hemispherical or globose, abruptly contracted into a short thick stem-like base, smoky brown above, white below, minutely areolato-furfuraceous, dehiscing by a small irre-

gular mouth. Capillitium continuous with the well-developed cellular sterile base, threads varying in thickness, simple, firm; spores bright citrin, then olivaceous-umber, globose, smooth, sometimes stipitate, 4 μ diam.—*L. pusillum*, Cooke, in Science Gossip, Dec. 1886. Plate XIII. figs. 24–26.

From 1/2–2/3 in. across. Gregarious. On the ground. England (Kew Gardens, Norfolk), Albany, U.S., Port Jackson, Australia.

53. *L. rugosum*, B. & C., Cuban Fungi, No. 504, Journ. Linn. Soc., x. p. 345.—Irregularly subglobose or turbinate, peridium thick tomentose, rugoso-plicate below, stem very short, thick, ending in a knob-like root. Capillitium continuous with the ample, convex, compact, sterile stratum, threads equal, width about same as diameter of spores, rarely branched, much curled and intricately woven into a dense felted mass; spores ochraceous, globose, smooth, 4 μ diam.

2–3 in. in diam. Hard and woody when dry. Sometimes two or three spring from the same root. On the ground. Ceylon, Cuba, Niger Expedition.

54. *L. polymorphum*, Vitt. Mon., 183.—Peridium flaccid, persistent, subglobose or depressed, sessile, or passing into a short stout stem, often more or less plicate below, dehiscing by a small orifice, minutely warted, cinereous. Capillitium continuous with the more or less developed floccose compact sterile basal portion, and forming a slightly elevated columella; spores dark dirty olive, globose, smooth, pedicellate, 3–4 μ diam.—Vitt. Mon., t. 2, f. 8. *L. furfuraceum*, Schaeff., t. 294. *L. cepæforme*, Bull., t. 435, f. 2 (bottom row).

Very variable in size and form; never cup-shaped and open when old. In sterile places. Summer and autumn. Europe, Algeria.

55. *L. ericæum*, Bon. Bot. Ztg., 1857, 628.—Peridium subrotund contracted into a very short plicate base, granulose, always obtuse, dehiscing by an apical laciniate mouth, yellowish brown when mature; spores minute, globose, smooth, olivaceous. Europe.

V. *Spores elliptical or subglobose.*

56. *L. radicatum*, D. R. & Mont., Fl. Alg., p. 383.—Globose or obovate, outer coat smooth, breaking away in patches, upper portion eventually evanescent, leaving an irregular large opening, root stout, elongated. Threads of capillitium much and irregularly branched, variable in thickness, tapering, continuous with the well-developed cellular base; spores umber, broadly elliptical, smooth, often pedicellate, 6×4 μ diam.

In sandy places. Algeria. Size variable, up to about $1\frac{1}{2}$ in. diam.

57. *L. phlebophorum*, B. & Br., Fungi of Ceylon, No. 719, Journ. Linn. Soc., xiv. 79.—Irregularly reniform or subglobose, ochraceous, with raised reticulations, between which are minute mealy warts; stem short, attenuated downwards, and terminating in a few branched white fibres. Threads of capillitium thinner than diameter of spores, equal, sterile base cellular; spores broadly elliptical, smooth, ochraceous, 5×3–4 μ diam.

Amongst leaves. Ceylon.

58. *L. Sinclairi*, Berk., in Herb.—Globose, produced into a short thick rooting base; peridium smooth, almost polished, cortex rufous, broken into adnate patches by growth and showing pale ochre between, base reticulato-plicate, upper portion evanescent, forming a large aperture with torn edge. Capillitium separating from the copious slightly cellular sterile base, threads branched; spores bright olive, smooth, broadly obovate, frequently furnished with a short pedicel, $5 \times 4\ \mu$.

On the ground. New Zealand.

59. *L. Gardneri*, Berk., Ceylon Fungi, No. 716, Journ. Linn. Soc., xiv. 79.—Peridium subhemispherical, fulvous, minutely floccose or mealy, plicate below and passing into the stout obconic stem. Capillitium persistent, threads rarely branched, flaccid, flexuous or contorted, sterile base compact; spores pale ochraceous, subglobose, slightly produced at the point attached to the persistent pedicel, smooth, longest diameter $5\ \mu$ diam.

Peridium 3–5 in. diam. Some of the specimens in Berkeley's herbarium have a stout long root.

In shady woods. Ceylon, Venezuela, South Africa.

Species belonging to Group A, *but owing to absence of type specimens and information as to surface of spores, could not be arranged under the sections.*

I. *Spores purple, lilac, or various shades of brown or umber.*

60. *L. laxum*, Bon. Bot. Ztg., 1857, 614.—Peridium capitate constricted into a soft often lacunose stem-like base, cortex woolly, breaking away in woolly warts; spores becoming dusky purple.

Europe.

61. *L. rusticum*, Bon. Bot. Ztg., 1857, 614.—Peridium large, capitate, contracted into a stout stem-like base, at first yellowish grey, bristling with spines, then greyish umber and areolate, at length alutaceous, cracked. Spores dusky.

In pine woods. Europe.

62. *L. clavatum* (Fr.), Bon. Bot. Ztg., 1857.—Clavate or elongato-pyriform, peridium papyraceous, tough, brownish, dehiscing by a large irregular opening. Capillitium compact, with the spores brown, sterile stem-like base ample.

Bovista clavata, Fr. Syst. Myc., iii. 23.

On the ground. Iceland. 4 in. high by 2 in. wide above.

63. *L. pistilliforme*, Bon. Bot. Ztg., 1857, 613.—Peridium pistilliform, capitate, yellow-brown, stem long, elastic, bright brown inside. Capillitium and subpedicellate spores brown.

Europe.

64. *L. alveolatum*, Lev. Ann. Sci. Nat., 1846, p. 163.—Peridium subglobose, membranaceous, passing into a short obconic stem-like base, covered with small angular micaceous warts, broken up in an areolato-sinuous manner. Capillitium and spores fulvous.

From 4–5 cm. diam. On the ground. Neilgherries, India.

65. *L. aculeatum* (Rostk.), Bon. Bot. Ztg., 1857.—Spherico-depressed, obtuse, plicate below, densely covered with long spinose warts,

very fragile above, breaking away in patches, leaving a wide irregular opening, stem stout, cellular. Capillitium and spores umber, evanescent. —*Langermannia aculeata*, Rostk., in Sturm, t. 13.

About $2\frac{1}{2}$ in. high, 1 in. broad. Europe.

66. *L. areolatum*, Rostk., in Sturm, t. 5.—Spherico-depressed, tapering into the stem-like base; peridium membranaceous, persistent, cortex broken up into areolæ, dehiscing by a small toothed umbonate mouth, stem cellular. Flocci forming a columella, spores brown.

About 2 in. high, $1\frac{1}{2}$ in. broad. Europe.

67. *L. flavescens* (Rostk.), Bon. Bot. Ztg., 1857.—Pyriform with a stout cellular stem-like base, very obtuse, yellowish, very brittle above where it is covered with minute scale-like warts, breaking away in areolæ and leaving a wide opening. Capillitium evanescent, with the spores brown.—*Langermannia flavescens*, Rostk., in Sturm, t. 14. *L. truncatum*, Batsch, t. 42, f. 230, *a, b*? *L. defossum*, Batsch, t. 42, f. 229, *a*?

About 2 in. high, $1\frac{1}{2}$ in. broad above. On the ground in pine woods. Europe.

68. *L. punctatum* (Rostk.), Bon. Bot. Ztg., 1857.—Peridium depresso-globose, contracted into a stout, equal, lacunose, cellular stem, yellowish, minutely punctate, above fragile, breaking away in areolæ and leaving a wide cup-like opening. Capillitium evanescent, with the spores brown.—*Langermannia punctata*, Rostk., in Sturm, t. 12.

Europe.

69. *L. pertusum*, Sow. Fungi, t. 412, f. 2.—Subglobose or slightly contracted into a short thick stem-like base. Peridium membranaceous, evanescent above, at first covered with minute furfuraceous warts, at length smooth and becoming perforated by numerous irregular holes. Capillitium pallid.—Berk. Ann. Nat. Hist., vii. 454.

About 1 in. across.

"It is remarkable for bursting extremely raggedly, and having a number of holes in it, at first sight looking very much like insect holes; it is also generally so weak, that it becomes almost pendant by the root."—Sow.

Among moss on the stem of a beech. England (Berks).

The Rev. M. J. Berkeley, F.R.S., has described a plant from Arctic America which he considers to be identical with the present species, which has not been recognized in England since Sowerby's time. "About the size of a hazel nut. Precisely the plant of Sowerby, except that his species is figured with a spurious stem. It is clearly no *Rhizopogon* as asserted by Fries."—M. J. B.

2. *Spores olive or various shades of yellow.*

70. *L. suberosum* (Fr.), Bon. Bot. Ztg., 1857.—Depresso-globose contracted into a stout cellular stem-like base, peridium very thick, corky, bark breaking away, dehiscing by an irregular large opening. Capillitium compact, and with the spores obscure alive.—*Bovista suberosa*, Fr. Syst. Myc., iii. 26. Rostk., in Sturm, t. 2.

About 2 in. across. Europe.

71. *L. candidum* (Rostk.), Bon. Bot. Ztg., 1857.—White. Spherico-depressed, obtuse, above very fragile and breaking away, leaving a very wide irregular opening. Capillitium evanescent, with the spores yellow, sterile base well developed, continued into a stout twisted tapering root. —*Langermannia candida*, Rostk., in Sturm, t. 11.

About $1\frac{1}{2}$ in. wide by 3/4 in. high. Europe.

72. *L. lætum*, Berk. Hook. Journ., 1843, p. 419.—Peridium subglobose or lenticular, contracted into a stout stem-like cellular base, at first covered with pyramidal warts, subcoriaceous, becoming rimoso-areolate and breaking away above, leaving a cup-like opening. Spores at first yellow, becoming smoky yellow.

Peridium about $1\frac{1}{2}$ in. high, $1\frac{3}{4}$ in. broad, pale; stem 3/4 in. high, 1 in. thick, reddish brown, furfuraceous. On the ground. Cape of Good Hope.

B. *Sterile basal stratum, rudimentary or obsolete.*

I. *Spores globose, rough, purple, lilac, or various shades of brown.*

73. *L. tephrospermum*, B. & C., Cuban Fungi, No. 509, Journ. Linn. Soc., x. 345.—Sessile, globose, peridium thick, leathery, whitish, with minute tomentose warts; root consisting of a dense mass of white fibres. Capillitium umber, threads firm, rarely branching, wider than diameter of spores at thickest part, tapering, sterile stratum obsolete; spores dark brown, globose, minutely warted, 3–4 μ.

From 1/2–1 in. in diameter. On the ground. Cuba.

74. *L. velutinum*, B. & C., Herb. Berk.—Subglobose or broadly obovate, sessile, peridium thick, persistent, bright brown, velvety; root of numerous dark fibres. Capillitium dense, threads about equal in thickness to diameter of spores, sterile base obsolete; spores ochre with a tinge of lilac, globose, very minutely warted, 4 μ diam.

About 1 in. across. On the ground. Venezuela.

75. *L. delicatum*, Berk. Hook. Journ., vi. 172 (1854).—Globose, membranaceous, thickly covered with minute granules, dehiscing by a small irregular mouth. Threads of capillitium varying in thickness, often contorted, tapering, frequently branched, axils acute, sterile base small; spores brownish purple, globose, echinulate, often with a long pedicle, 6 μ diam.

From 1–2 in. across. On the ground. Khasia Mountains, N.W. Himalayas.

76. *L. epixylon*, B. & C., Cuban Fungi, No. 508, &c., Journ. Linn. Soc., x. 345.—Sessile, hemispherical, rufous densely covered with minute adnate granules. Threads of capillitium flexuous, branched, very delicate, sterile portion obsolete; spores umber, globose, strongly echinulate, 6 μ diam.

Peridium 1/2–1 in. diam. On rotten wood. Cuba.

II. *Spores globose, rough, brownish olive, olive, or various shades of yellow.*

77. *L. fuligineum*, B. & C., Cuban Fungi, No. 506, Journ. Linn. Soc., x. 345.—Peridium subglobose or obovate, fuliginous, becoming

paler towards the base, minutely tomentose, debiscing by a small dentate mouth. Threads of capillitium flaccid, sterile stratum obsolete; spores pale reddish ochre, globose, echinulate, 4 μ diam.

Peridium 1 in. or more in diam. On rotten trunks. Cuba.

78. *L. Vittadinii* Mass., nov. sp.—Globose, sessile; peridium rigid, woolly, mouth small, irregular, rufous when dry. Capillitium dense, threads firm, flexuous, about equal in thickness to diameter of spores, sterile base obsolete. Spores brownish olive, globose, strongly echinulate, 4 μ diam.

Sent by Vittadini to the Rev. M. J. Berkeley as *L. defossum*, along with another specimen which was the true *L. defossum*, as described by Vittadini. A striking illustration of the worthlessness of external characters alone in the discrimination of species.

About 2/3 in. across. Italy.

79. *L. subincarnatum*, Peck, N.Y. Nat. Hist. Mus. Bot. Report (24th).—Peridium globose, rarely either depressed or obovate, gregarious or cæspitose, sessile, with but little cellular tissue at the base, covered with minute nearly uniform pyramidal or subspinulose at length deciduous warts, pinkish brown, the denuded peridium whitish or cinereous, minutely reticulate-pitted; capillitium and spores greenish yellow, then dingy, olivaceous, columella present; spores minutely rough, 0·00016–0·00018 in. in diameter (= about 4–5 μ).

From 1/2 to 1 in. broad. Sometimes has white fibrous roots like *L. pyriforme*.

Prostrate trunks, old stumps, &c., in woods. Common. Aug.–Oct. United States.

III. *Spores globose, smooth, purple, lilac, or various shades of brown.*

80. *L. pusio*, B. & C., Cuban Fungi, No. 503, Journ. Linn. Soc., x. 344.—Globose, smooth, thick, corrugated when dry, mycelium forming a dense fibrous rooting mass. Capillitium dense, threads often two to three times thicker than diameter of spores, firm, tapering, sterile base obsolete; spores purple-umber, globose, smooth, from 2–3 μ diam.

About 1/3 in. diam. On rotten wood, into which the mycelium penetrates deeply. Cuba.

81. *L. Astrocaryi*, Berk. & Cke., Brazil Fungi, Journ. Linn. Soc., xv. 393.—Sessile, globose, attached by a broad base, brown, minutely granulate, dehiscing by a small subrotund mouth. Threads of capillitium slender, collapsing, sterile base almost obsolete; spores dirty ochre, eventually assuming a lilac tinge, smooth, globose, 3 μ diam.

From 1/4–1/2 in. across. On petioles of *Astrocaryum*. Brazil.

82. *L. Emodense*, Berk., in Hook. Journ., vi. 172 (1854).—Ovate, passing into a very short stem, peridium minutely furfuraceo-squamulose, rufous, dehiscing by a large irregularly torn mouth; root of long white branched fibres. Threads of capillitium branched, axils acute, varying in thickness, flexuous, basal barren stratum obsolete; spores brownish umber, globose, smooth, 4 μ diam.

About 1 in. high, 3/4 in. thick. On the ground, sometimes growing in clusters. Sikkim Himalayas (9–10,000 ft.), E. Nepaul (9000 ft.).

83. *L. australe*, Berk. Fl. Tasm., ii. 266.—Sessile, globoso-depressed, densely covered with small pointed warts, which are smaller and granular towards the base, eventually disappearing and leaving the surface smooth and shining, dehiscing by a small raised mouth, root long, tapering. Capillitium very dense, persistent, threads very variable in thickness, branched, axils rather acute, scanty sterile base cellular; spores umber, globose, smooth, generally furnished with a long pedicel, 5 μ diam.

1 in. or more in diameter. On the ground. Melbourne, Tasmania.

84. *L. rubellum*, B. & C., Cuban Fungi, No. 507, Journ. Linn. Soc., x. 345.—Sessile, obovate or subglobose, rufous, rough with minute spinose warts, becoming smooth, dehiscing by a small apical opening, often with white fibrous mycelium. Capillitium dense, threads generally thicker than diameter of spores, much branched, axils rounded, sterile base scanty, compact; spores umber, globose, smooth, 5 μ diam.

From 1/2–2/3 in. diam. On rotten wood. Cuba.

85. *L. Brasiliense*, Fr. Syst. Myc., iii. 40.—Globose, sometimes with a short stem, brownish when dry, peridium membranaceous, flaccid, persistent, with minute adnate warts, mouth small, obtuse, root white, branching. Threads of capillitium equal, about same thickness as diameter of spores, rarely branching, lax, sterile base almost obsolete; spores brown, globose, smooth, 3–4 μ diam.

From 1/2–2/3 in. across. Cæspitose, on trunks. Brazil, Pegu.

86. *L. Wrightii*, B. & C., Grev., ii. p. 50.—Sessile, globose, papyraceous, at first covered with minute spinose warts, becoming smooth, dehiscing by a minute silky orifice. Threads of capillitium firm, sparsely branched, axils acute, often contorted towards the lips, sterile base obsolete; spores umber, globose, smooth, 4 μ diam.—*L. separans* Peck, N.Y. Nat. Hist. Mus. Bot. Report (26th).

$\frac{3}{4}$ in. diam. In Berkeley's description the spores are said to be *clay-coloured*. Connecticut, New Jersey.

IV. *Spores globose, smooth, brownish olive, olive, or various shades of yellow.*

87. *L. stellatum*, Cke. & Mass., Grev., March 1887.—Sessile, subglobose; peridium thin, flaccid, at first covered with stout stellate spinose warts, which break away in patches, leaving a smooth surface, mouth minute, torn. Threads of capillitium firm, rarely branched, equal in thickness to diameter of spores, continuous with the scanty floccose sterile base; spores dirty olive, smooth, globose, 5 μ diam. Plate XII. figs. 10–12.

About $1\frac{1}{2}$ in. across. On the ground, in clusters of two or three. Israelite Bay, S.W. Australia.

88. *L. substellatum*, B. & C., in Herb. Berk. — Globose, sessile, whitish, covered with delicate flocculose spines, becoming smaller downwards. Threads of capillitium collapsing, simple, sterile base obsolete, spores ochraceous, globose, smooth, 3 μ diam.

From 1/4–1/2 in. across. On rotten wood. Cuba.

89. *L. cruciatum*, Rostk., in Sturm, t. 8.—Subpyriform or subglobose, bristling with stout spinose warts which are often split up at

the base in a cruciate manner, breaking away in patches and leaving a brown minutely velvety surface. Threads of capillitium thicker than diameter of spores, flaccid, often contorted, tapering, barren basal stratum almost obsolete; spores ochraceous-cinnamon, smooth, globose, 4 μ diam.—*Utraria cruciata*, Quel. Jur. et Vosg., 359.

From 2/3 to 1 in. high. Sometimes rooting. Europe. Rhode Island.

90. *L. grumosum*, B. & C., Herb. Berk.—Globose, sessile, plicate below and passing abruptly into a slender root, peridium thin, tough, almost smooth. Capillitium very dense, continuous with the compact scanty sterile base, threads about equal in thickness to diameter of spores, much interlaced; spores ochraceous-olive, globose, smooth, 4 μ diam.

About $1\frac{1}{2}$ in. across. On the ground. Cuba.

91. *L. muricatum*, Bon. Bot. Ztg., 1857, 612.—Obconic or lentiform contracted into a very short furrowed base, at first white and above covered with triangulose spinose warts, then umbonate, becoming smooth and brown. Threads of capillitium about thickness of diameter of spores, flexuous, tapering, sterile base almost obsolete; spores umber, tinged olive, smooth, globose, often with a long pedicel, 5 μ diam.—Fuckel, Fungi Rhenani, Exs., No. 1257.

From 1–2 in. broad. In pine woods and sandy pastures. Germany.

92. *L. turbinatum*, B. & C., Cuban Fungi, No. 510, Journ. Linn. Soc., x. 345.—Turbinate, passing into a long tapering root, glabrous, reddish umber. Capillitium dense, threads about equal in thickness to diameter of spores, flexuous; scanty sterile base compact; spores dirty cinnamon, globose, smooth, 4 μ diam.

Peridium about $1\frac{1}{2}$ in. diam. On rotten wood in dense forests. Cuba.

93. *L. microspermum*, Berk. Hook. Journ., vi. p. 172 (1854).—Subglobose, flaccid, persistent, at first with small acute warts, becoming smooth, dehiscing by a small round mouth, root usually elongated. Threads of capillitium much wider than diameter of spores, firm, branched, axils rounded, tapering flexuous towards the tips; sterile base obsolete; spores brownish olive, globose, smooth, 2–3 μ diam.

Peridium 1/2–1 in. across. On the ground. Darjeeling, India, New Zealand.

94. *L. citrinum*, B. & Br., Ceylon Fungi, No. 724, Journ. Linn. Soc., xiv. 80.—Broadly elliptic, sessile, pale citrin minutely warted, dehiscing by a small apical opening, root long cord-like. Threads of capillitium of varying thickness, tapering, frequently branched, sterile base cellular, scanty; spores pale olive, globose, smooth, often pedicellate, 5 μ diam.

From 1/2–2/3 in. diam. On the ground. Ceylon.

95. *L. flavum*, Mass., nov. sp.—Globose, yellowish olive, fibrillose or minutely furfuraceous, dehiscing by a small apical mouth. Threads of capillitium very variable in thickness with slender scattered spines, rarely branched, sterile base obsolete, spores dirty lemon yellow, globose, smooth, 5 μ diam. Plate XIII. figs. 27–29.

About 1 in. across. On the ground. Cape of Good Hope.

96. *L. dermoxanthum*, Vitt. Mon., p. 177.—Peridium very thin and flaccid, persistent, sessile, irregularly globose, base more or less

plicate, root rather long, slender; minutely furfuraceous, dehiscing by a minute opening, bright yellow, becoming brownish. Threads of capillitium very slender, lax; sterile portion obsolete; spores ochraceous-olive, globose, smooth, 3–4 μ diam.—Vitt., t. 2, f. 2. Mich. Gen., t. 97, f. 3.

Variable in size, from 1/2–1½ in. In grassy places. July–Oct. Italy, Algeria.

97. *L. defossum*, Vitt. Mon., p. 177, t. 2, f. 2.—Peridium thick, rigid, globose, sessile, floccose, dehiscing by a small aperture. Threads of capillitium thicker than diameter of spores, branched, tapering, basal sterile stratum obsolete; spores ochraceous olive, becoming almost umber, globose, smooth, with a short pedicel, 5 μ diam.

From 1/2–3/4 in. across. In sandy places. At first subterranean, emerging from the ground when mature; the floccose cortex generally carries along with it a quantity of sand which becomes agglutinated by mucus from the inner diffluent wall of the peridium. Italy.

98. *L. conspurcatum*, B. & Br., Ceylon Fungi, No. 723, Linn. Journ., xiv. p. 80.—Globose, sessile, peridium thin, minutely warted, here and there cracked into areolæ, base short, rooting. Capillitium floccose, continuous with the minute sterile base; spores olive, globose, smooth, often pedicellate, 4 μ diam.

Scarcely 1 in. in diameter. On the ground. Ceylon.

99. *L. reticulatum*, Berk., in Herb.—Peridium globose or broadly obovate, with slightly raised reticulations which eventually disappear, leaving a polished surface. Capillitium persistent, threads slender, flaccid, barren stratum scanty, cellular; spores pale yellowish grey, globose, smooth, 4 μ diam.

About 3/4 in. diam. Australia, New Zealand.

100. *L. cepæforme*, Bull., t. 403, f. 2 (upper row).—Sessile, subglobose, peridium papyraceous, persistent, cortex white, minutely furfuraceous, breaking away in patches, dehiscing by a minute torn mouth, root long, cord-like. Threads of capillitium much branched, thicker than diameter of spores, much branched, axils rounded, sterile base obsolete, spores bright citrin, smooth, globose, often with a short thick pedicel, 4 μ diam.—*L. pratense*, Pers. Syn. Fung., p. 143. *Globularia furfuracea*, Quel. Champ. Jur. et Vosg., 361. Vittadini's figure of *L. plumbeum*, t. 33, f. 1, Fung. Mang., very much resembles Bulliard's figure, but in the former the spores are said to be "fusco-purpurea."

About 1 in. across. Europe.

101. *L. Cubense*, Berk., in Herb.—Subglobose, peridium thick, tomentose, root a dense mass of white fibres. Threads of capillitium flaccid, simple, barren stratum almost obsolete, spores ochraceous, globose, smooth, 3 μ diam.

From 1/2–1 in. across. Amongst decayed leaves. Cuba.

102. *L. leprosum*, B. & Rav., Fungi Car. Exs., No. 14.—Sessile, globose, whitish, with scurfy granules, mouth small. Capillitium continuous with the minute sterile base, threads about three times as thick as diameter of spores, flaccid, not branched; spores yellowish olive, globose, smooth, often shortly pedicellate, 3 μ diam.

Scarcely 1/2 in. across. Amongst moss on trunks. S. Carolina, Georgia, Florida.

103. *L. tephrum*, Berk., in Herb.—Sessile, globose, peridium thick and rigid, brown, minutely velvety. Capillitium scanty, threads delicate, sterile base obsolete; spores pale ochraceous olive, globose, smooth, 3–4 μ diam.

From 1/2–2/3 in. across, sometimes with a branched rooting base. Brisbane.

104. *L. scrobiculatum*, Ces. Myc. Born., 12.—Subspherical, bay coloured, scrobiculate. Sterile base inconspicuous, spores globose, smooth, yellowish.

Size and general appearance of *Lycogalus epidendrum* (Ces.). On decayed grass stems. Sarawak.

105. *L. albinum*, Cke., in Herb.—Sessile, globose, white, minutely mealy. Threads of capillitium scanty, slender, flaccid, sterile base almost obsolete; spores clay colour, smooth, globose, 3 μ diam.

Peridium 1/2–1/3 in. across. On rotten wood and branches. Brazil.

106. *L. pusillum* Fr.—Peridium subglobose, sometimes slightly attenuated below, flaccid, persistent, with minute adpressed scurfy squamules, becoming smooth, dehiscing by a minute irregular apical pore, pale olivaceous ochre, furnished with a cord-like root. Capillitium dense, threads much branched, axils well rounded, lax, flexuous, sterile base obsolete; spores olivaceous ochre, globose, smooth, 4 μ diam.—*L. pusillum*, Fr. S. M., iii. 33. Cke. Hdbk., 1086. Eng. Fl., 304 (in part). Karst. Myc. Fenn., iii. p. 360. Batsch, Elen., f. 228, var. Bolt., t. 117, f. C. Schaeff. Ic., t. 294. Bull., t. 435, f. 2. Fckl. Exs., No. 1261. *Globularia pusilla*, Quel. Champ. Jur. et Vosg., ii. t. 3, f. 7.

From 1/4–2/3 in. diam. Europe, North America, Bonin Islands, Lower Pegu, Hong Kong, Whampoa, East Nepaul, Rio Janeiro, Ceylon, New Zealand, Melbourne, Somerset East (Africa), King George's Sound.

107. *L. calyptræforme*, Berk. Grev., ii. p. 50.—Ovate, apex papillate, furfuraceous or with minute mealy warts, base rooting. Threads of capillitium much thicker than diameter of spores, sterile stratum obsolete; spores dirty ochraceous, smooth, globose, 3 μ diam. Plate XIII. figs. 16 and 17.

About 1/3 in. across. Upper Carolina.

V. *Spores elliptical or subglobose.*

108. *L. oblongisporum*, B. & C., Cuban Fungi, No. 505, Journ. Linn. Soc., x. 345.—Sessile, subglobose, pale brown, with minute persistent warts. Capillitium continuous with the minute sterile base, threads about equal to short diameter of spores, branched, axils acute; spores brown, smooth, elliptic-oblong, 6×3 μ diam. Plate XII. figs. 8 and 9.

Up to 1 in. diam. Amongst leaves. Cuba.

109. *L. Hongkongense*, B. & C., Proc. Amer. Acad., 1859, 124. —Pyriform or elliptical, with minute warts above, becoming smooth, dehiscing by an irregular apical aperture; rooting. Capillitium reddish ochre, sterile base obsolete; spores subferruginous, elliptic, smooth, pedicellate, 4–2 μ diam.

About 2/3 in. high. On the ground. Hong Kong.

110. *L. plicatum*, B. & C., Proc. Amer. Acad., 1859, 125.—Subrotund or depressed, white becoming pale brown, cortex with minute warts, splitting away above, plicate below and produced into a very short stem. Capillitium continuous with the scanty sterile base; spores broadly elliptic, smooth, often shortly pedicellate.

From 1/2–2/3 in. diam. On the ground. Japan.

111. *L. gauterioides*, B. & Br., Fungi Ceylon, No. 718, Journ. Linn. Soc., xiv. p. 79.—Irregular, suborbicular, leathery, citrin. minutely furfuraceous, rugoso-lacunose especially below, stem very short. Threads of capillitium much branched, axils rounded, sterile base scanty; spores olive, smooth, broadly elliptic. $5 \times 4\ \mu$ diam.

A little over 1 in. diam. On scorched ground. Ceylon.

112. *L. coloratum*, Peck, N.Y. Nat. Hist. Mus. Bot. Report (29th) —Peridium globose or obovate, subsessile, radicating, yellow or reddish-yellow, brownish when old, slightly roughened with minute granular or furfuraceous persistent warts; capillitium and spores at first pale, inclining to sulphur colour, then dingy olive; spores subglobose, smooth, about 0·00016 in. diam. (= about $4\ \mu$).—U.S. Sp. Lycop., pp. 29–30.

"There is a slight depression in one side of the spore, so that when viewed in a particular direction, it appears flattened or depressed on one side, although if viewed in a different direction it may appear globose."

Less than 1 in. across. Ground in thin woods and bushy places. Rare. July and August. United States.

113. *L. xanthospermum*, Berk. Hook. Journ., vi. p. 172 (1854).—Globose or broadly obovate, peridium thin, persistent, yellowish with minute brown specks of outer peridium remaining. Threads of capillitium firm, simple, about equal in thickness to diameter of spores, continuous with the scanty cellular base; spores dark yellow tinged olive, smooth, subglobose, generally pedicellate, about $5\ \mu$ diam.

About 1 in. diam. Not furfuraceous. On the ground. Khasia, India.

Species belonging to group B, *but owing to absence of type specimens and information as to surface of spores, could not be arranged under the sections.*

114. *L. tomentosum*, Vitt. Mon. Lyc., p. 179.—Peridium very thin, persistent, chestnut brown, covered with evanescent tomentum, dehiscing by a minute mouth. Sterile base none, spores olive-brown.—Vitt., t. 1, f. 10.

In dry pastures, semi-immersed. Aug.–Sept. Italy.

115. *L. purpurascens*, B. & C., Proc. Amer. Acad., 1859, 124.—Small, subglobose, contracted into a sub-aculeate base, purplish then brown, innato-squamulose above. Sterile stratum obsolete, spores yellowish olive.

On decayed trunks. Bonin Islands.

116. *L. mundula*, Kalch, Grev., ix. p. 3 (1880).—Peridium floccose, becoming smooth, white, size of a hazel-nut. Spores and capillitium carneo-rufous, 0·004 mm. diam.

Similar to *L. pusillum*, but colour of spores different. Australia.

The following species could not be arranged under Groups A or B, owing to imperfect descriptions, and absence of type specimens:—

1. *Spores purple, lilac, or various shades of umber or brown.*

117. *L. asperrimum*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 289, t. 20, f. 14.—Subglobose, 1 in. or more high, peridium cinnamon, papyraceous, when young bristling with spines, becoming smooth, capillitium reddish; spores same colour, globose, minutely echinulate, 4 μ diam.

Amongst bushes in sandy places. West Africa.

118. *L. Welwitschii* Mass. — Peridium globose or subturbinate, horny, fragile, blackish purple, clothed with dense rufous tomentum. Capillitium brown, spores brown, very minutely echinulate, about 3 μ diam.—*L. tomentosum*, Welw. & Curr., Fungi Angol., Linn. Trans., xxvi. p. 289, t. 19, f. 7–8 (1868). There is a *L. tomentosum* Vitt. of prior date.

On damp ground, amongst rotten leaves. Golungo, West Africa.

119. *L. Novæ Zealandiæ*, Lev. Ann. Sci. Nat., 1846, p. 164.—Peridium globose, sessile, papyraceous, evanescent above and opening by a very large mouth, at first covered with minute white shining warts, lacunoso-plicate below, flesh and smooth spores violet.

From 5–7 cm. diam. On the ground. New Zealand.

120. *L. cæspitosum*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. pp. 289–90, t. 20, f. 1–2.—Subglobose; 1/4–1½ in. high, 1/4–1½ in. across, rooting, white when growing, yellowish when dry, papyraceous, at first warted then almost naked; capillitium argillaceous lilac, yellowish under the Microscope; spores same colour, globose, smooth, 5–6 μ diam.

In grassy places. West Africa; Somerset East, Africa.

121. *L. serotinum*, Bon. Bot. Ztg., 1857, 631.—Globose, always obtuse, contracted into a short rooting base, above with rufous-brown spines, yellowish-white becoming ochraceous brown, dehiscing by an entire mouth. Spores brownish ochre, minute, globose, smooth.

Near trunks and roots. Europe.

122. *L. fuscum*, Bon. Bot. Ztg., 1857, 626.—Small, pyriform or obconic, at first with white spines of various sizes, becoming yellowish and granuloso-floccose, umbonate, at length brown, mouth entire or laciniate. Spores yellow-brown, minute, smooth.

Europe.

123. *L. cretaceum*, Berk. Linn. Journ., xvii. p. 15.—Sessile, globoso-depressed, pale fulvous, scabroso-pulveraceous, above broken up into rigid chalky pyramidal areolæ; mycelium creeping, white. Capillitium brown, threads coarse, irregular, spores 0·005–0·007 mm.

Bellot Island (Arct. Exp.).

124. *L. gossypinum*, Bull. Champ., p. 147, pl. 435, f. 1.—Minute, subturbinate; peridium flaccid, minutely woolly, spores brown.

From 2–3 lines across. Peridium white, becoming brownish. Gregarious on rotten wood. France.

2. *Spores tinged with olive or various shades of yellow.*

125. *L. fœtidum*, Bon. Bot. Ztg., 1857, 629.—Shape variable, often deformed, brown or bay, bristling with simple and angular spinose warts which fall away leaving reticulate markings, becoming subumbonate and dehiscing by a terminal mouth. Spores small, globose, smooth, rufous-olive or greenish brown.

Smell like *Scleroderma vulgare*. In woods. Europe.

126. *L. sculptum*, Harkn. Bull. Calif. Acad. Sc., Feb. 1885, p. 160, pl. 1.—Subglobose or obovate, 8–15 cm. in diam., pure white. Outer peridium very thick, forming pyramidal masses 2–4 cm. in breadth and $1\frac{1}{2}$–3 in. in height, which are longitudinally grooved by many parallel lines; in age dividing vertically into several segments which usually remain attached at the apex: spore mass bright yellow, becoming cinereous; flocci yellow, 6–10 μ; spores smooth, pale, 5–8 μ.

Sierra Nevada, 6–8000 ft.

127. *L. Gunnii*, Berk. Fl. Tasm., ii. 265.—Sessile, subglobose, with very minute stellate warts. Columella short, spores bright olive, globose, with long pedicels, 1/6000 in. diam.

Olive, 1–2 in. diam. In pastures. Tasmania, Australia.

128. *L. golungense*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 289, t. 20, f. 13.—Peridium globose or obovate, clothed with delicate fastigiate tomentum, springing from a dense mass of mycelium; capillitium and spores unknown.

At the base of rotten trunks. West Africa.

129. *L. furfuraceum*, Batsch, Elen., p. 145.—"Sessile, globose, furfuraceo-squamose.—Mich., 97, f. 6."

Europe.

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SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Theory of Sex and Reproduction.‡—In a paper entitled "Theory of Growth, Reproduction, Sex, and Heredity," Mr. P. Geddes seeks to interpret these in terms of their "fundamental secret, that of constructive and destructive metabolism—anabolism and katabolism."

(1) Following Spencer, *growth* is more intimately defined as the preponderance of an anabolic tendency, rhythm or diathesis, while the limit of growth corresponds to the maximum of katabolic preponderance consistent with life, in other words to the climax of the katabolic diathesis.

(2) *Reproduction* in all its forms is similarly treated. Like continuous cell-division, asexual reproduction occurs when waste or katabolic processes are in the ascendant. The phylogenetic evolution of sexual dimorphism, which is briefly summarized, is interpretable as the gradual differentiation of comparatively sluggish, more nutritive, preponderatingly anabolic (female) cells, and more mobile, finally more exhausted, and emphatically katabolic (male) elements. The evolution of *fertilization* by gradual stages from the almost mechanical flowing together of exhausted cells (or plasmodia) is sketched. By reference to aphides, plants, &c., the author illustrates how, just as asexual reproduction occurs at the limit of growth, a check to the asexual process involves the appearance of the sexual, which is thus only associated with katabolic preponderance. In many fungi it may be seen that the greater the anabolism the less sexuality. Some beautiful and suggestive illustrations are given of the relation of sexual to asexual reproduction. *Alternation of generations* is interpreted as a rhythm between a relatively anabolic and katabolic preponderance, and other phenomena of reproduction are similarly rationalized.

(3) *Nature of Sex.*—Proceeding first on inductive lines, the author shows (*a*) that the male and female elements exhibit in fundamental and concentrated expression the katabolic and anabolic antithesis; (*b*) that the same

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Proc. R. Soc. Edin., 1886, pp. 911-31.

is well illustrated in the incipiently dimorphic reproductive elements of *Volvox* and the like; (*c*) that male tissues, like those of an anther, exhibit signs of predominant katabolism; (*d*) that the female organs of *Chara* or *Nitella* correspond in position to the vegetative anabolic internodal cells, and the male organs to the smaller, dividing nodal cells; (*e*) that over a wide area the sum total of female characteristics—more vegetative, nutritive, conservative, &c.—are interpretable as anabolic, and that the average male characteristics—smaller size, more active habit, higher temperature, shorter life, &c.—are similarly the expression of a predominant katabolic diathesis; and (*f*) that in the conditions affecting the determination of sex, influences inducing katabolism tend to result in production of males, as those favouring anabolism similarly go to increase the probability of females.

And then deductively, Mr. Geddes proceeds to apply this notion of anabolic "femaleness" and katabolic "maleness" to the reproductive elements in their various forms and phenomena, to the processes of maturation in oogenesis and spermatogenesis, to the physiology of fertilization, to the tissues, organs, forms, and habits of the two sexes.

(4) In regard to *heredity*, the author chiefly emphasizes the now familiar notion of the direct continuity between the rudimentary reproductive organs of the embryo and the parent ovum. The protoplasmic continuity is in itself a partial explanation of the continuity in history. For "if the reproductive elements start with a specific protoplasm continuous with that of the combined mother ovum and fertilizing sperm—that is, with a concentrated accumulation of characteristic anastates and katastates, the simple fact that the products of protoplasmic change must be fixed, definite, and continuous, as in all chemical processes, gives us at once a protoplasmic basis from which to explain the constant and necessary symmetry of segmentation and development." While, if superficial acquired characters be indeed inherited, "it must not be forgotten that all the organs do to a certain extent share mutually in nutriment and waste products, and that thus, besides the characteristic specific protoplasm acquired through direct continuity, both germinal cells and developing embryo may accumulate a proportion of characteristic anastates and katastates, acquired, as it were, pangenetically" from the organs of the body.

(5) The ingenious and suggestive paper closes with an application of the above conceptions to the genealogical tree as a whole. In this the author seeks to show how we are to "look forward to the solution of the problem of ætiology in deeper terms than those of 'natural selection' alone, as illustrations, namely, of a continuous rhythm of anabolic and katabolic change."

History and Theory of Spermatogenesis.*—Messrs. P. Geddes and J. Arthur Thomson have given (1) an historical account of the progress of research in regard to the process of spermatogenesis, and have sought (2) to collate in tabular form the all too-confusing nomenclature of the subject, for which a symbolic notation is suggested. (3) After noting the various homologies between oogenesis and spermatogenesis, the authors seek to unify and rationalize the various modes of spermatogenesis described by different authorities, by comparing them in detail with the various forms of segmentation. This suggestion has also been made, though not followed up, by Herrmann (1881), and has been hinted at in the nomenclature of Balfour and others. The aim of the paper is to suggest that the multitudinous details of spermatogenesis can be morphologically rationalized by collating them with the details of ovum segmentation. A bibliography and explanatory plate are added.

* Proc. R. Soc. Edin., 1886, pp. 803–23 (1 pl.).

Spermatogenesis of Mammalia.*—Herr C. Benda communicates a full report of his recent researches on the process of spermatogenesis in mammals. His investigation is based upon the ox, the rabbit, the guinea-pig, the boar, the rat, the mouse, the dog, and the cat.

(1) The seminal canals of Mammalia include two functionally different elements—the mother-cells (Stammzellen) with their derivatives, and the basal-cells (Fusszellen). (2) The process of spermatogenesis is accomplished in four stages—(*a*) Multiplication of mother-cells; (*b*) formation of sperm-cells (Samenzellen) from some of the mother-cells; (*c*) copulation between the basal-cells and the former; (*d*) modification of the thus united sperm-cells into spermatozoa. (3) All the four acts occur by successive displacement (schubweise).

(4) The multiplication of mother-cells occurs by indirect cell-divisions in the most external cellular layer of the seminal canal. (5) The formation of a row of sperm-cells is effected by a preparative alteration in the position of the mother-cells. The latter multiply by indirect division in the inner layers of the canal, and some of the results form reserve mother-cells.

(6) After the perfecting of a generation of sperm-cells, the basal-cells in the outermost zone conjugate with them, each basal-cell uniting with a number of sperm-cells. (7) Contemporaneously with or immediately after the occurrence of this conjugation the sperm-cells begin to be modified into spermatozoa. (8) The nucleus forms the various parts; the cellular body is dissolved. (9) The portion of the nucleus nearer the point of copulation forms the head, the reverse the tail. (10) During their entire modification the sperm-cells remain in organic connection with the basal-cell, and form by active and passive modifications of the latter a bundle of spermatozoa. (11) They are expelled as they actively or passively lose their connection with the basal-cell, and are pressed out laterally by the proliferation of adjacent elements.

(12) The various steps occur regularly in each part of the tubule, so that certain events in successive rows of seminiferous cells always coincide. Thus the close of a period of modification coincides with that of the multiplication of sperm-cells; the beginning of the former occurs at the same time as the preparative alterations of the mother-cells; these preparative changes always occupy the same time as two periods of modification; two rows of sperm-cells are always in process at the same time; the close of each process of modification is contemporaneous with the perfecting of a generation of sperm-cells, so that at the end of modification the material for the next period is already in progress. (13) In each portion of a seminal tubule it is therefore possible to have a periodic secretion of spermatozoa, and an unbroken succession. (14) The secretory periods in the different portions of the tubule do not coincide. (15) By a regular alternation of the secretory periods in the different parts of the tubules there is a possibility for continuous secretion throughout the mammalian testis.

Significance of the Yolk in Osseous Fishes.†—Mr. E. E. Prince is of opinion that the yolk of the Teleostean egg is accessory, an appendage not directly contributing to the building up of the tissues, but mainly serving to furnish pabulum to the delicate and rudimentary embryo on emerging from the egg; the presence of large oleaginous spheres in the yolk confirms this view, for these globules appear to have no intimate connection with development.

If this view be correct, the germ is discoblastic, and the invaginated

* Arch. f. Mikr. Anat., xxx. (1887) pp. 49–110 (3 pls.).
† Ann. and Mag. Nat. Hist., xix. (1887) pp. 1–8 (1 pl.).

rim must be regarded as the primitive enteric involution, like the inflected arc in Elasmobranchs or Amphibians. The important feature in the teleostean egg is that the germinal matter is so concentrated at one pole as to have little more connection with the yolk than that of juxtaposition; if this be so, a less distorted and more primitive condition may have been resumed; this supposition explains how, with a great bulk of yolk, the blastopore of osseous fishes is symmetrical, and coincides with the entire inflected margin of the germ.

Development of Ichthyophis glutinosa.*—Herren P. and F. Sarasin found two kinds of dermal sensory organs in the skin of the larvæ and the oldest embryo of *Ichthyophis glutinosa.* The nervous elevations which are found in other Amphibia are very well developed; beneath each organ the nerve forms a small ganglionic swelling, the elevations are set on a papilla of the cutis which incloses a large blood-sinus, and through the middle of this the nerve passes. The basal processes which the authors first regarded as nervous are now looked upon as being connective-tissue-fibres.

In addition to these there are organs of another kind in the skin of the head; these are flask-like structures with a narrow neck open to the exterior; as a rule, these organs consist merely of two layers of cells, the inner being truly sensory, and the outer supporting; the sensory cells have long stiff hairs which project into the cavity of the organs, and on them there moves a refractive club-shaped body, which is so held by the hairs that it nowhere touches the wall of the organ; we seem here to have to do with a true dermal auditory organ, and it is interesting to observe that the sensory cells of this dermal organ are exactly like the auditory cells of the true ear of *Ichthyophis.* The club-like body is easily dissolved, and appears to be formed by the secretion of the supporting cells of the organ. The resemblance of the organs of the lateral line to auditory organs has been frequently noted; here, in *Icthhyophis,* the organ may be justifiably called a subsidiary ear. Later in development it appears to undergo glandular degeneration.

Why do certain Fish-ova float?†—After referring to a statement by Prince as to the buoyancy of certain fish-ova, Mr. J. A. Ryder gives some notes on the subject.

There are three chief types of buoyant ova: (1) Those in which the specific gravity of the yolk is diminished, as in the cod; (2) those in which large oil-drops in an excentric position aid in causing the eggs to float; and (3) those in which a single large oil-drop causes the ovum to float even in fresh water. These types are connected by intermediate forms. As a rule the buoyant ovum has a single large oil-drop imbedded in the vitellus at the opposite pole to the germinal disc; buoyant ova float singly; are transparent; have thin membranes which do not adhere. *Macropodus venustus,* a fresh-water form, has buoyant ova, in which the relative volume of the oil-drop is greater than in any other form; and in this form the oil is the sole cause of the buoyancy, since the plasma, when freed, sinks. With the exception of this ovum, buoyant ova require water of a greater density than 1·014.

Fermentations by Protoplasm of a recently-killed animal.‡—M. Fokker states that he has been able to demonstrate that the fermentations which, since the experiments of Pasteur, it has been usual to regard as due to microbes, are produced also by the protoplasm of a normal tissue. If a

* Zool. Anzeig., x. (1887) pp. 194–7. † Amer. Natural., xx. (1886) pp. 986–7.
‡ Comptes Rendus, civ. (1887) pp. 1730–2.

small portion of an organ is taken from an animal that has been recently killed, with every precaution against Bacteria, and if this portion be placed in a sterilized medium and treated in a digester, it can convert sugar into acid and starch into glucose; but the most careful investigation by the Microscope and by cultivations cannot demonstrate the presence of microbes. After some hours, the production of acid is arrested owing to that which has been formed stopping the action of the protoplasm, but the formation goes on again as soon as the acid is neutralized by a suitable quantity of potash. The only difference between the action of the protoplasm and that of microbes is one of quantity; that being smaller in the former case.

The author thinks that these experiments prove that the difference lies in the reproductive power of the microbes; he has nothing in common with Liebig, for in his experiments the tissues do not decompose, but feed themselves and continue to live; the only symptom of decomposition is the destruction of the nuclei. "A tissue removed from a healthy animal and digested in a nutrient medium does not multiply, but it does live, and the fermentation to which it gives rise is a proof of it."

Embryo-chemical Investigations.*—Herr L. Liebermann has investigated the chemical constitution of various portions of the eggs of fowls. (1) The *vitelline membrane* was dexterously isolated, and purified, subjected to various qualitative tests, and finally analysed. The average result of analysis gave a composition unlike that of any known albuminoid, viz. C 46·21, H 7·55, N 12·20, S 3·62, O 30·42, in percentages. (2) The *chalaza* gave similar qualitative reactions, but the percentage composition was different, e. g. C 48·26 or 47·94, H 9·81 or 8·07. (3) *The membranes penetrating the albumen* also turned out to be different, e. g. C 50·95 and H 7·24 per cent. The three substances are thus different from one another and from albumen. They have had separate origins or have arisen from albumen by different processes.

Concentrated caustic potash not only swells the vitelline membrane, but causes it to adhere to glass. Prof. Liebermann took advantage of this to study the effects of reagents on the germinal disc. It was also tested *in situ*. The detailed results are communicated. It consists principally of albuminoid substances, but lecithin or something similar is also present. The presence of sulphur (albumen) was also demonstrated in the germinal spot, which became quite black after treatment with strong alkaline lead solution.

B. INVERTEBRATA.

Otocysts as Organs of Locomotor Orientation.†—Prof. Y. Delage has made a number of experiments with a view of determining the functions of the otocysts of various Invertebrates. His results, put shortly, are to this effect: the destruction of the otocysts produces a disorganization in the power of locomotor orientation in animals subjected to it; this result is due to the abolition of the functions of the organ, and not to its excitation or to the irritation of a nerve connected with it; the almost total suppression of visual and tactile sensations does not produce any effect of this kind; sight and touch may, in a certain degree, take the place of the destroyed otocysts, but in most cases the locomotor disorganization is only diminished by the indications afforded by these two senses. The otocysts, in addition to their auditory function, play the part of organs which regulate locomotion, and they probably do this by provoking, in a reflex manner, the corrective

* Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 66–77.
† Arch. Zool. Expér. et Gén., v. (1887) pp. 1–26.

muscular actions which maintain the body in its desired course, and in its normal orientation during the whole period of movement. There are good reasons for believing that these organs also send to the cerebral ganglia true sensations which inform the animal as to the movements of rotation which are actively or passively effected by its own body. These sensations, as well as the preceding reflex acts, may be provoked by mechanical action exercised, during the movements, by the fluid or by the otoliths on the nervous terminations in its walls.

As to the interesting question, which of the two functions—auditory and regulative—is the more important, the author suggests that in the animals which move but little—such as the Lamellibranchiata—the auditory functions may be the more useful, while in Cephalopods and Crustacea he has no doubt that the regulative is the more important.

To the obvious objection that may be raised against this new theory—the fact that there are a number of Invertebrates which move about and do very well without otocysts—Prof. Delage urges that the otocysts are not the only organs that are capable of performing this regulative function; in some, as e.g. *Mysis*, the organ of sight so well performs the function of the otocysts, that the ablation of the latter is not noticed so long as sight remains uninjured; and we may, therefore, suppose that in Insects the absent otocysts are entirely replaced by the eye.

If this be so, and if there is no other organ which specially replaces the otocysts, we ought to prove in Insects, by the ablation of the eye, the same disordered locomotion as obtains in Crustacea and Cephalopoda when the otocysts are destroyed. On this point the author has made a few experiments which appears to confirm his views, but he promises to make a more extended investigation into the subject.

Pelagic and Littoral Fauna of North German Lakes.*—Dr. O. Zacharias has investigated the pelagic and littoral fauna of the North German lakes. He found twelve species and six varieties of pelagic Entomostraca, *Bosmina crassicornis* and *Temorella lacustris* being new species; the former was worked out by Prof. Lilljeborg; thirty-one littoral forms and two ecto-parasites are enumerated; attention is specially directed to a completely rosy-red variety of *Sida crystallina;* the red pigment was in the hypodermis of the carapace.

No Hydrachnida were found in the central zone of the large lakes; thirty-one species were found near the shore.

As to the Rotatoria, attention was only given to those genera and species which are constant members of the pelagic fauna, and which indicate it by special characters of organization, such as the completely glassy transparency and absence of protective colours in some species, or by the possession of spine-like cuticular processes such as are developed in not a few species of *Anuræa.* It appears that these processes serve to support the delicate animal in the water.

The most common cilio-flagellate is *Ceratium hirundinella* Bergh; although *Dinobrya* are exceedingly common in Swiss lakes, there was no indication of them in those of North Germany.

Of Turbellaria, *Bothromesostoma Essenii* was observed, and a few additions made to Braun's observations on its structure; the most important part is the very peculiar character of the enteric epithelium in those individuals which contain ripe embryos; in them the enteric cells exhibited an indication to isolation, and were only loosely held together; the embryos break through the extremely thin wall of the uterus, and make their way,

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 255–81 (1 pl.).

at the point of least resistance, into the enteric cavity, and so escape by the mouth to the exterior. Although this phenomenon has been observed by Graff in several Proboscida, it has never yet been seen in the family of the Mesostomida. *Castrada radiata* and *Gyrator hermaphroditus* were also common, but on the whole the Turbellarian fauna of these lakes appears to be small.

Mollusca.

Anatomy and Histology of Salivary Glands of Cephalopoda.*—M. L. Joubin has discovered that the pair of salivary glands which in the Cephalopoda octopoda lies against the buccal bulb, is not, as has been thought, absent in the Decapoda, but forms a single unpaired gland which lies beneath the œsophagus, and is closely connected with the muscular bundles. The gland found on one side of the tongue of *Octopus vulgaris* by M. Livon, has been detected by the author in all the species which he has examined; the acini of which it is composed open into the space which separates the tongue from the mandible.

In Octopods, the extra-bulbar salivary glands are situated in large blood-lacunæ, and the blood which supplies them escapes peripherally by a large number of pores which are really spaces between the superficial acini. In Decapods the glands are not bathed in a blood-sinus, and the blood which traverses them is collected by a venous plexus.

If sections are made of glands taken from living animals, and very carefully prepared with osmic acid, it may be seen that in all Cephalopods, the lingual, the unpaired subœsophageal, and the extra-bulbar glands are formed on the same type. They consist of groups of acini formed of somewhat short cylindrical cells filled in their lower third by protoplasm, with a large nucleus; in the median third there is a plexus of protoplasm, and the rest is filled by rather large granulations which colour deeply. They have a close resemblance to the serous cells of Vertebrates. On the other hand, the pair of abdominal glands is formed by large conical cells, of which the narrow lower part contains the protoplasm, while the upper two-thirds are filled with large spheres of mucus; they have a remarkable analogy with the mucous cells of higher vertebrates. In the Decapoda the abdominal gland is small and acinous, but in the Octopoda it is very large and tubular. All the tubes of which it is made up are twisted in such a way as to form an inextricable plexus, the spaces in which are filled by connective fibres, or large stellate cells, or which form blood-spaces.

Development of the Squid.†—M. L. Vialleton finds that when the egg of the squid leaves its follicle and falls into the cavity of the body it is ovoid in form and consists of a chorion, the nutrient yolk which forms nearly the whole of its mass, and the formative yolk which is perfectly distinct, and forms a plate which may be easily separated. At its centre (below the micropyle), the plate is thick and formed of a granular protoplasm which passes insensibly into the peripheral hyaline portion. The germinal vesicle has already disappeared, and the first directive spindle is to be found near the centre of the area granulosa of the formative yolk. After oviposition, this last is a little displaced; at its periphery two polar bodies are distinguishable, and in the interior there are two nuclei which may be small and distant from one another, larger and closer, or fused into one. These are the male and female pronuclei; they differ in size, the smaller being the male. The first cleavage groove has the same direction as that taken by the pronuclei in approaching one another. In the second

* Comptes Rendus, iv. (1887) pp. 177–9. † Zool. Anzeig., x. (1887) pp. 383–7.

stage there is a larger and a smaller blastomere on either side of the first groove, the larger occupying the part in which were the polar globules, and which may be called anterior or superior. In the third stage the superior commence to divide before the inferior blastomeres, and, as this becomes more marked, we get an intermediate stage with fourteen blastomeres. When the sixteen appear, two kinds of elements may be distinguished; those which are separated and individualized the author proposes to call "blastomeres," while the others, which are continuous at their periphery with the unsegmented formative yolk, he calls "blastocones." In the fifth stage the first segment (or what most authors call blastomere), counting from above, divides across and gives rise to a blastocone and a blastomere, the second divides longitudinally and forms two blastocones, the third and sixth divide longitudinally, the second and fourth transversely. In the next intermediate stages we have twenty blastocones and eight blastomeres, and later on, thirty blastocones and eighty blastomeres, owing to the transverse divisions which produce the blastomeres having been more frequent in later stages of segmentation.

The segmentation of Cephalopods calls to mind that of other Mollusca, the blastocones representing the macromeres, and being, like them, produced by a kind of budding from the blastomeres (which are the equivalent of the micromeres); the incomplete separation of the former is regarded as a secondary process.

As the blastocones divide and form rays around the blastoderm the elements produced by it separate from one another, their contour becoming less distinct; their protoplasm becomes hollowed out with vacuoles and gradually diffuses into the hyaline layer, so that in place of an element of definite form we only have a nucleus surrounded by a very small quantity of granular protoplasm. The blastomeres, then, form a circular plate (blastoderm), which will give rise to the body of the embryo, while the blastocones have formed a plasmodium which will become the perivitelline membrane; this last becomes intercalated between the blastoderm and vitellus, and in time comes to separate them completely; it is not formed, as Prof. Lankester thought, by vitelline nuclei, but arises from the first two segmentation-nuclei.

Development of Reproductive Organs in Gasteropods.*—Prof. C. Semper subjects to a searching criticism the recent conclusions of Brock † in regard to the development of the reproductive organs in Gasteropods. Brock's conclusions were based on a study of *Limax agrestis*, and may be roughly summed up as follows:—(1) At a very early stage the thin hermaphrodite duct is connected with the genital atrium and associated penial diverticulum by a somewhat thicker canal—the primary genital duct. (2) The vas deferens arises as a blind canal from the end of the penis, while the primary genital duct splits into two adjacent canals, the female and male ducts. (3) The latter is a provisional and transient structure, and from the remaining half there develope both oviduct and spermatoduct. (4) The free vas deferens, arising as above noted from the penis, unites with the female duct before it divides into oviduct and spermatoduct. (5) The spermatheca arises as a fine diverticulum from the base of the penis, at the point where the latter is inserted along with the oviduct in the genital atrium.

So much for Brock's conclusions, which Semper proceeds to criticize. The male duct is said to disappear without trace, but of this no proof is

* Arbeit. Zool.-zoot. Inst. Würzburg, viii. (1887) p. 213.
† See this Journal, *ante*, p. 58.

given. Not even Brock's own figures lend support to this conclusion. On the contrary, Semper believes that Ranzaud was right in deriving the spermatheca and its stalk from a splitting of the primary genital duct. Nor do Brock's figures seem to Semper to support his statement that the spermatheca arises at the same time as, or slightly before, the male duct begins to separate off. To Semper it appears that the male genital duct of Brock does indeed separate off from the primary genital duct, not, however, to disappear, but to become spermatheca and stalk. And further, that what Brock calls the spermatheca is no such thing, but a glandular appendage of the atrium and neck of the penis, homologous with the mucous gland and Cupid's dart-sac.

According to Brock the spermatheca is a development from the penis. But in a dissection of *Helix pomatia* made many years ago in Prof. Semper's laboratory the following interesting relation was observed and afterwards confirmed. At the point where the oviduct and vas deferens begin to separate a short duct arises, which connects the origin of the separate vas deferens with the stalk of the spermatheca. The latter in this case has retained its primitive connection with the hermaphrodite duct. The very variable diverticula on the stalk of the spermatheca, seen in so many Stylommatophora, are thus explicable as nothing more than the upper ends of the "male genital duct" of Brock. These have separated from their connection with the common genital duct, but have not degenerated to the extent observed in a normal *Helix pomatia* or *Limax*, where they have disappeared except at that point where the spermatheca arises. Each of the aforesaid diverticula is a rudiment of the upper (proximal) end of the separated male duct. Semper's opinion, then, is that the spermatheca is a lateral diverticulum from the male duct as this becomes gradually separated from the hermaphrodite duct, and that the variable diverticula on the stalk of the spermatheca are so many retrogressive developments of the upper end of the male duct, and that the connection between the hermaphrodite duct and the spermatheca above described is a frequent persistent structure (Hemmungsbildung). The paper concludes with a hit at naturalists who are ready to explain all divergent facts in terms of their theory without analysis of the facts involved.

Central Nervous System of Acephalous Mollusca.*—Dr. B. Rawitz was led to study the acephalous Mollusca from the supposition that the simplicity of the arrangement of their central nervous system would be very suitable for investigating the significance of the so-called commissures, and the origin of the nerves. He examined *Pholas dactylus, Mya arenaria, Cardium edule, Unio pictorum, Mytilus edulis*, and others.

With regard to his histological results, the following are the most important points; the central nervous system contains no apolar cells, unipolar cells are the most and bipolar cells the least common; multipolar cells are less frequent than the former, and more frequent than the latter. Some of the unipolar cells have their process going directly to the periphery, but the peripheral processes of all other cells sink into and become lost in the medullary substance; the multipolar cells are collecting-cells, and their medullary process is the homologue of Deiter's process.

The medullary substance is formed (*a*) of a central nervous plexus, which is formed by the intermingling of the products of the division of the medullary processes; (*b*) of nerve-fibrils which are formed from the meshes of the nerve-plexus; and (*c*) of a substance which resembles the nervous medulla of the Vertebrates, which forms the characteristic myelin, and

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 384–460 (5 pls.).

which isolates the filaments of the plexus and the fibrils. The author is of opinion that the medullary substance in the central nervous system of the Acephala is the homologue of the white substance in the same organ of Vertebrates; cells surround the medullary substance in cortical fashion. Between the cells of the cortex and in the medullary substance there is no structure either homologous with or analogous to the neuroglia of Vertebrates. The processes of the inner envelope which sink in between the cells of the cerebral and visceral ganglia of *Pecten* are homologous with the pericellular tissue which is found in the intervertebral ganglia of Vertebrates. The peripheral nerves of the Acephala consist of simple axial fibrils, and exhibit no tendency to group themselves into broader fibres. There is a considerable exchange of fibres between ganglia of different names (e. g. cerebral and pedal), and an incomplete crossing between the fibres of the similarly named organs (e. g. visceral ganglia).

This last character is very interesting physiologically; if one touches an open lamellibranch on any part of its body, it immediately closes up, and, if it be a siphoniate form, it draws in its siphons; in other words, the least peripheral stimulus leads at once to a combined action of all the muscles of the edge of the mantle, of the foot, and of the shell, and must therefore be perceived in all parts of the body equally and simultaneously. The connectives and commissures may be regarded as containing a system of association-fibres of the most highly developed form. The importance of this extreme sensitiveness of the tactile organs to these (nearly always) blind animals must be very great.

The morphological conclusions to which the author has been led do not differ in any important particular from those reached by previous investigators. He differs, however, from his predecessors as to the systematic position of the Ostræidæ, for while they have regarded that group as a very low one, he regards it as having a high position. This view is based on the high value which the author attaches to the development of the visceral ganglion; he points out that this stands in relation to the development of the edge of the mantle as the chief concentration-point of the most important sensory organs; as the Ostræidæ have the most highly developed visceral ganglion, they are the highest of the Mollusca Acephala. Dr. Rawitz combats the view that the development of the visceral ganglion is correlated with that of the gills.

Jouannetia cumingii Sow.*—Herr E. Egger has made a morphological study of *Jouannetia cumingii* Sow., which, with its much contracted body, represents one extreme derivative of the *Pholas* type, while the long *Teredo* represents the other. The material for the investigation of this rare mollusc was obtained from Prof. Semper's Philippine collection. Instead of following the morphological details, it will be more profitable to compress the author's summary of the main results.

Most of the peculiarities of *Jouannetia cumingii*, as compared with other members of the *Pholas* family, are associated with the considerable reduction of the longitudinal axis. These peculiarities are to be regarded as modifications in more or less direct response to the external conditions of life. Those organs would be first influenced which have most to do with the external world, viz. the shell, the musculature, and the boring apparatus. The shortening of the shell is almost a mechanical result of the peculiar boring. The consequence is the approximation of the adductor muscles; the posterior one especially appears to be shunted forward towards the centre of revolution of the shell. By this shortening of what corre-

* Arbeit. Zool.-zoot. Inst. Würzburg, viii. (1887) pp. 129-99 (4 pls.).

sponds to the arm of the lever, its power would be reduced, were it not for compensation involved in an immense increase of volume and a most efficient insertion on specifically peculiar muscle apophyses. Similar adaptations are well known in other animals.

There are also secondary modifications associated by correlation of organs with the primary. The strengthening and approximation of the two shell-muscles involves a considerable reduction of the space between them. It is therefore natural that the organs in this region are modified by mutual pressure. By a shortening of its longitudinal axis the ventricle of the heart comes to lie quite transversely, the dorsal vessel exhibits a sharp bend, the posterior aorta being forced to pass for some distance in front of the ventricle, so as to reach along with the rectum (which penetrates the ventricle inferiorly and posteriorly) the upper surface of the posterior adductor. The auricles remain approximately equal in length, but their form is modified by the lateral horns of the kidney, which are insinuated between the former and the base of the gills. The same position of the organs occasions the restriction of the openings of the vasa revehentia branchiarum to a very restricted portion of the anterior end of the wall of auricle. That portion of the kidney which represents the typical pair of tubes in the most nearly related forms is also compressed longitudinally, so that it forms a simple transverse sack, the "central portion." This restriction of the secreting area must be compensated for in some way. This can only occur by the development of diverticula between the adjacent organs. There are two pairs of such structures extending forward from the central portion. The dorsal pair are insinuated between the posterior adductor and the pericardium forward to the rectum; the two lateral horns of the kidney lie between auricle and base of gills. In these the glandular epithelium is abundantly folded inwards. The shortening of the ureter is not, however, compensated for in any way, length being for such an organ of no moment. In the nervous system, the centres of which lie before and behind the region of most modification, the effect of shortening is only seen in the relatively slight length of the commissure between cerebral and visceral ganglia. In the gills, on the other hand, the marked shortening of the lamellæ is probably made up for by an increase in thickness. The shortening is also associated with the appearance of a special membrane which completely separates the mantle cavity into anal and branchial chambers. The third adductor of the shells, which has been differentiated from the pallial muscle, is also conspicuously short. The other organs, such as stomach, intestine, enteric appendages, central portions of nervous system (with the exception of the enigmatical small ganglion in front of the visceral) are not within the range of the most modified region, and show but slight deviations from the ordinary *Pholas* type.

The form of the accessory shell-pieces ought also to be interpretable in relation to external conditions. The shape of the shortened shell of the young form is of a skullcap-shape; the young animal can bore a perfectly round hole in the coral block; this dwelling-place determines the form of the fresh pieces. The shell of the adult must complete the sphere.

The mobile larva, the young boring form with toothed shell and muscular foot, the sexually mature adults, all exhibit modifications corresponding to their different conditions. These are discussed in the course of the memoir.

Jouannetia cumingii is connected with the more typical forms by a series of transitional stages. It stands itself as the extreme of a long row of forms. *Pholas dactylus* and similar forms may be taken as primitive types of the open Pholadidæ. The closed types pass in their young forms

through a stage resembling the latter, but this is less marked in the extreme *Jouannetia*, where the closure of the anterior mantle aperture by the mantle diaphragm occurs at a very early stage when the anterior shell opening and foot are still present. This also can be interpreted in association with external conditions and the form of the young shell. The memoir, of which the results are outlined above, is obviously conspicuous for its attempt not merely to chronicle, but to rationalize the morphological facts.

Molluscoida.

a. Tunicata.

Normal and Teratological Embryology of Ascidians.*—M. L. Chabry has investigated the normal embryology of *Ascidia aspersa*, and has also made a number of experiments and observations on artificially produced monsters.

In its normal segmentation the egg of this species has considerable resemblance to that of *Clavellina rissoana*, as described by E. van Beneden and Julin, and that of *Clavellina* sp. studied by Seeliger. Notwithstanding the apparent irregularity of the segmentation, it has been found possible to homologize the early cells with those of animals not closely related, and these points are explained by the aid of a diagram.

In the formation of the blastodermic layers *A. aspersa* most closely resembles *Phallusia mammillata;* attention is drawn to the segmented condition of two lateral mesodermal bands as an indication of metameric segmentation; the author establishes the primitively double character of the eye, otolith, and notochord.

With regard to the origin of normal monsters, the author shows that most arise from monstrous germs formed by certain parents; the following are the chief points in monstrous formations:—There is a deviation of a facet of segmentation. Segmentation is limited to the nucleus, or is retarded, or does not happen; the cells migrate abnormally, or fuse, or die. The number of monstrous forms is, naturally, immense, and they are so connected one with another as to render a single natural classification quite impossible.

The experiments made on the production of monsters have an interest to the general physiologist, or to the student of the special facts of embryology and teratology. As to the former, we have evidence that the production of "traumatismes cellulaires" causes the affected cells to change in form, consistency, and appearance in a manner which is as sudden as it is remarkable. They die rapidly, while the cells which have not been affected undergo correlative changes in form and position; from this the author concludes that each blastomere has a natural form, different from that which it can take in the egg, where it is in contact with the blastomeres. The blastomeres, are, in fact, ovoid, elastic masses, movable on one another; the actual form of each of them and their reciprocal action are the result of a mechanical equilibrium, due to their attraction, their natural form, and their hardness. Every segmented ovum, whether normal or abnormal, is a system in equilibrium, and it is impossible to alter the position or the form of any one of its parts without the others passing spontaneously and immediately into another state of equilibrium. The reciprocal attraction or cohesion of the blastomeres is also the physical cause of other phenomena; it explains the continuity of the dorsal cord which persists in most monsters, the integrity of the ectoderm, and so on.

* Journ. Anat. et Physiol. (Robin) xxiii. (1887) pp. 167–319 (5 pls.).

There are other phenomena which are not purely physical, but are of a vital nature; these are the amœboid deformations. M. Chabry has found that these do not take place by chance, but that certain deformations are repeated in exactly the same way for every cell in the normal egg. Each blastomere is, therefore, characterized, when in the normal state, not only by size, form, and proper position, but by a succession of determinate forms.

From the teratological point of view, it is of interest to note that injury to a blastomere results in the suppression of development of the organs potentially contained in that cell; but at the same time it is to be noted, that it occasionally happens that by the death of one cell the power of the survivors is changed, and they then give rise to parts which, in normal circumstances, they would not have produced.

β. Polyzoa.

Development of Cyclostomatous Marine Bryozoa.*—Herr A. Ostroumoff did not succeed in finding any earlier stage than one which consisted of epiblast and endoblast, such as has been figured by Metschnikoff in cross sections; in longitudinal sections the author found at the equatorial plane, on either side of the embryo, three large epiblast cells; these correspond to the corona or ciliated zone which exists in the larvæ of other marine Ectoprocta, where it consists of a row of long cells. The embryo grows rapidly; when the cells of the vegetative pole invaginate to form the sucker cavity the embryo has a remarkable resemblance to a gastrula. Later on the circular fold which is to form the mantle appears round the animal pole; its cavity is not formed by the insinking of this pole, but in consequence of the growth of the margin of the fold. With regard to the share taken by the endoderm, Barrois and Metschnikoff differ; the author detected a small endodermal cavity, the wall of which was formed of small flattened cells, but at the sides the walls were seen to be breaking up. At the end of the period of embryonic development there is no sign of this cavity. Herr Ostroumoff thinks that Metschnikoff took the mantle-cavity for the endodermal one.

The larva, after swimming about freely for some time, attaches itself by its sucker, the hind wall of which is extended into a broad round basal plate, which secretes largely a cuticular substance on its free surface. The mantle bends down and fuses with the periphery of the basal plate, the fusion occurring in the part where are the higher, apparently glandular cells. The ring-like vestibulum becomes completely closed, the cilia soon cease to move, and the cells that bear them fall away. At one point the ectodermal cells become differentiated in the form of a cellular plate which becomes more distinct a little later on; this is the ectodermal rudiment of the polypide. The period at which the plate becomes marked off varies with various Cyclostomata.

A striking point is the development of a special endothelial sheath around the nutrient tube; this is a temporary structure, which, after a time, completely disappears.

The stage which the author, with Barrois, looks upon as that of the primitive Bryozoon, presents the following characters; it consists of two surfaces divided by a cleft which leads into the vestibular ring; the vestibule is formed by the ciliated cells of the larval skin and the anterior wall of the sucker; one of its surfaces may be called the pallial, since it is formed at the expense of the walls of the mantle-cavity, while the other is the basal

* MT. Zool. Stat. Neapel, vii. (1887) pp. 177–90 (1 pl.).

surface and is formed by the hinder wall of the sucker. In the succeeding stages the vestibular ring begins to disappear, and the boundaries between its two surfaces are formed by the glandular cells; at the expense of the pallial surface the tube of the primary zoœcium is formed, and at that of the basal the base of the tube. The zoœcium gets the form of a casket, and this the author looks upon as a primary form, regarding the tube as having been phylogenetically acquired later on. The basal side soon gives rise to a lobate outgrowth, which, from its mode of development, appears to be homologous to the stolon of the Vesiculariidæ.

In *Crisia*, gemmation obtains without the basal wall taking any part in it; among the Chilostomata the same appears to be true of *Bugula*.

The author regards the cephalic amnion-cavity of *Sipunculus nudus*, as described by Hatschek, as comparable to the mantle-cavity of these Bryozoa. All these structures belong to one of two types; there are either two investments which disappear when the animal takes on its definite form, as in *Pilidium*, or the larval integument alone disappears as in Desor's larva and *Sipunculus*. In the Bryozoon the investments pass into the organism, where they are used as food. This is the difference between these structures in various worms and in the Bryozoa, and is sufficiently explained by the absence of the functional nutrient tube during metamorphosis. In typical cases (Chilostomata and Cyclostomata), the sucker belongs to the first type, and its thinner anterior wall represents the amnion; but the mantle belongs to the second type. In the freshwater Bryozoa the mantle belongs to the first type.

Development of Alcyonella fungosa.*—Dr. A. Korotneff draws attention to a remarkable peculiarity in the development of *Alcyonella fungosa* which has not yet been noticed. After the development of a perfectly typical planula there appears a circular fold, which, later on, forms a cap which invests the anterior part of the body. Metschnikoff thought that this cap appeared rather late, while Reinhard was of opinion that the developing fold appeared before the buds of the polypide. Dr. Korotneff himself found that the fold might apparently arise either before or after the buds. This difference led to the following discovery; if the planula possesses two differentiated layers, and is of an elongate form, but without buds, there arises around and a little above the middle of the planula, a circular fold, which consists only of ectoderm, and becomes closely attached to the inner surface of the oœcial sac; at the point of junction the cells of the inner layer become altered in the same way as those of the fold, and there is seen a close circular fusion of the planula with the oœcium; this line of fusion becomes broader and band-like, and there is thus formed a true zonary placenta. Reinhard took the commencement of the formation of the placenta for the formation of the cap, but the true cap, as Metschnikoff rightly observed, arises much later; after the connection of the planula with the oœcium is effected, there appear at the upper pole of the planula two buds, which are rightly regarded as finger-like depressions of the wall, and which consist of ectoderm and endoderm. After the appearance of the buds another fold is developed in the middle line, a little below the zonary placenta; this may be distinguished by consisting of both ecto- and endoderm. As this second fold grows it pushes the placenta upwards; this latter at the same time begins to undergo degeneration—the cell-boundaries begin to disappear, and granules appear in the cells; the zonary placenta becomes a mass which occupies the whole upper part of the oœcium, and it is possible that the

* Zool. Anzeig., x. (1887) pp. 193-4.

degenerated placenta serves as food for the developing polypide. If the planula of *Alcyonella* be compared with the annelid larva, the two folds may perhaps be regarded as two metamorphosed ciliary bands.

Characters of the Genus Lophopus.*—Mr. S. O. Ridley points out the unnatural characters by which genera and species of Phylactolæmatous Polyzoa are distinguished: as exampled in the separation of *Alcyonella* and *Plumatella*, which differ from one another chiefly in the "manner of connection between the tubes of the colony." He gives Allman's diagnosis of *Lophopus*, as well as Jullien's addendum to it, but the discovery of a new species necessitates the withdrawal of that portion of the latter's definition of the genus with regard to the spines of the statoblast.

Lophopus Lendenfeldii n. sp. is described, this being the first time the genus has been recorded from Australia; examples were also found in the Paramatta river, New South Wales. The new species differs from *L. crystallinus* in the absence of the terminal spines to the statoblast, and in the knobbed form of the inner end of the endocyst.

Arthropoda.

Simple Eyes in Arthropods.†—Mr. E. L. Mark is of opinion that Mr. Locy's observations settle some of the disputed points regarding the eyes of spider-like type. The formation of the retina from the epiblast, independently of the cephalic ganglia, settles the controversy so far as its hypodermal origin is in question. Some speculations are offered as to the causes and the real significance of the hypodermal infolding which accompanies the formation of ocelli. The first difficulty is this: if the retina, which is formed by a process of inversion, was once a normally located portion of the hypodermis, how could it have remained functional during the process of inversion? and, in the next place, what led to that inversion? It may be assumed that the primitive eye was composed of a single layer of modified hypodermal cells occupying the normal position (perpendicular) in relation to the surface of the head; that the proximal ends of the sensory cells were in connection with the nervous centre by means of nerve-fibres, and that the bacilli were formed in the distant or free ends of the cells. It seems to be reasonable to suppose that all the triplostichous eyes have passed through a condition of simple sac-like depression, in which the retinal cells were not originally inverted. From this two conditions have arisen: (1) By a closing together and fusion of the lips of the original depression a more or less voluminous cavity (filled with a so-called lens) was formed in front of the still uninverted retina, and behind a double layer of hypodermis: such a triplostichous condition obtains in *Peripatus*. (2) By an approximation of the walls of the depression the cavity would be reduced to an axial fissure; the cells corresponding to the "outer cornea" in the first case become the lentigen, those corresponding to the "inner cornea" become a vitreous body, while the retina still remains uninverted: this is the condition described by Grenacher in *Dytiscus*.

Two ways are suggested in which a change due to the action of the light may have been brought about: one is that light gained access to some portion of the periphery of the eye-bulb through other parts of the cuticula than that which originally served for the transmission of light, and that thus what was practically a new eye was developed out of a portion of the already existing retinal cells; to support this view we have the anterior median eye in *Agelena*, which, very probably, previously existed in the

* Journ. Linn. Soc. Lond., xx. (1887) pp. 61–4 (1 pl.).
† Bull. Mus. Comp. Zool. Camb., xiii. (1887) pp. 49–105 (5 pls.).

condition of a functional monostichous eye, the deep ends of whose retinal cells were directly continuous with the optic-nerve fibres; in the earliest stage of the present eye, before the appearance of the bacilli, the nerve-fibres emerge from the outer and posterior border of the retinal infolding immediately underneath the lentigen; on the development of the bacilli the fibres emerge further and further back from the surface of the head, until at last the nerve is separated by a considerable interval from the lentigenous cells. As the author points out, "this is exactly what might have been expected if the eye had been developed phylogenetically by the inversion of a layer of cells which were already in functional activity before the process of inversion began, and the deep ends of which were connected with the optic nerves. It is also consistent with the formation at the deep ends of the retinal cells of secondary bacilli, which may be regarded as the physical cause of a recession (ontogenetic) of the place where the optic nerve emerges." It is possible that the primitive bacilli do not in all cases completely atrophy; such a hypothesis would, at any rate, explain the problematic bodies which are found in the retina of scorpions—the phaospheres of Lankester and Bonnier.

The tapetum, to the presence of which it is possible to ascribe the retention of the original bacilli, does not seem to owe its iridescent scales to the cuticular secretions of the hypodermis. Mr. Mark thinks it more likely that the tapetum is formed from cells which grow from the apex of the original retinal involution into the cavity formed by that involution, and that they take the form of an outfolding. There is reason to suppose that the course of the optic nerve-fibres through the post-tapetal layers is a secondary condition; if, as is probable, post-nuclear eyes were developed from functional monostichous eyes, the deep ends of whose retinal cells were directly connected with the nerve-fibres, the fibres should retain their connection with the deep ends of the cells, and should, even in advanced stages, exhibit a course similar to that pursued by the nerve in "pre-nuclear" eyes at an early stage; but, instead of this, they traverse the post-retinal layer. This, however, is only a modification, and not a fundamental difference.

α. Insecta.

Directive Corpuscles in Eggs of Insects.*—Dr. F. Blochmann is of opinion that a sufficiently large number of eggs of Insects have now been examined to justify us in speaking definitely. In *Blatta* and in the Aphides directive corpuscles are formed in exactly the same way as in most other animals; but in *Musca* there are certain modifications; to put this in another way, we find that the more primitive forms, the Orthoptera and the Hemiptera have retained the primitive mode, while there are changes in the more differentiated Diptera; this may, perhaps, be correlated with what we know as to the various secondary modifications which obtain in the development of *Musca;* at any rate, it is striking that these cenogenetic processes should be observable in the very earliest stages of development.

In *Blatta* we can with absolute certainty, and in *Musca* with great probability, assert that the point of exit of the directive corpuscle marks the dorsal side of the future embryo, and herein the eggs of insects agree with those of other animals. It is still more important to note that this point of exit marks the animal pole, and may be taken as a fixed point in the topographical relations of the germinal stripe.

* Morphol. Jahrb., xii. (1887) pp. 544–74 (2 pls.).

In those eggs of the Aphides which develope parthenogenetically there is only one directive corpuscle, and therefore only one directive amphiaster; in the eggs that require fertilization there are two quite normal directive bodies. Weismann has made a similar observation with regard to the summer eggs of Daphnids, in which there is only one directive corpuscle.

Post-embryonal Development of Muscidæ.*—Prof. A. Kowalevsky observes that in the larva (and even in those which have just escaped from the egg) of the Muscidæ we find the rudiments of a number of organs which have no function in the larval stage; these imaginal organs develope more slowly than those which are functional in the larva. In addition to the already well known imaginal discs we find special imaginal rings and cells for the enteric canal, and special cells and groups of cells which form afresh the muscles of the imago. Ectoderm, mesoderm, and endoderm have their proper imaginal rudiments, which do not predominate in development until after the metamorphosis of the larva; when the pupal stage arrives the growth of the larval organs is ended, and the larval skin and muscles are inactive; they are now useless and are a disturbing element for the developing imaginal body, but they are seized and destroyed by the phagocytes. Special observations were made on the muscles, glands, and hypodermal cells; the muscles have the same appearance as in the larvæ, and the hypodermal cells have absolutely the same structure, so that we cannot have to do with dead or dying organs. The contents of the nuclei escape from them in the same way as the contents of the cell of *Spirogyra*, when attacked by *Vampyrella*, and this shows us that we have to do with living nuclei. As the whole phenomenon was studied in stained preparations and sections, the author thinks it well to add that the tissues and organs seized by the phagocytes exhibit the same relation to the staining reagents as do the functional organs of ripe larvæ; were these tissues dead, the appearance would be different.

The fact that the phagocytes do not seize on the freshly forming organs and tissues, but only upon those whose function is accomplished, shows us that the developing and actively living organ is not seized upon by the phagocytes; there must, in fact, be a certain functional weakness which permits of the organs being attacked by phagocytes. It is more difficult to explain the case of the fat-cells, but it may be suggested that these cells lose their power of assimilation during the metamorphosis, and so come into the category of weakened organs. The fact that the useless organs are not simply cast off, but eaten, digested, and converted into a fluid condition for the developing organs, is an example of the economy of the organism. All larvæ which cannot use up these weakened organs require more fat and other reserve material than those which use their muscle and larval integument just as if it were a prepared food; the latter is clearly the more useful method.

Histology of Insect Muscle.†—Herr R. v. Limbeck has investigated the histological differences between the two different kinds of muscles which can be readily distinguished in insects, even with the unaided eye. The observations of Retzius and Bremer, which by no means agreed with those of previous investigators, prompted the author to submit the facts to fresh examination. His material was always taken from freshly killed animals and treated in various ways. The muscles were sometimes frozen and cut at right angles to their axes, or treated with Löwit's gold-formic acid

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 542–94 (5 pls.).
† SB. K. Akad. Wiss. Wien, xci. (1885) pp. 322–49 (1 pl.).

method. Hardening with 1 per cent. superosmic acid was also resorted to. Hæmatoxylin alone, or in aqueous solution with potassium chromate, and gentian-violet were successfully used for staining.

When the hind leg and thorax of *Dytiscus marginalis*, for instance, are opened, the muscles in the former are seen to be beautifully white, while those of the thorax have a yellow, almost brownish colour. After removing the ventral wall and viscera, two conical white muscles are seen to spring from the dorsal portion of the posterior segment of the thorax and to have their apex inserted on the hind pair of legs. These are the white hip-muscles (Hüftmuskeln) which work the last pair of legs in and out. When these are removed, there are seen in front the yellowish-brown muscles which pass as strong beams between dorsal and ventral surfaces, and belong to the mechanism of flight.

I. *The muscles of flight* (in *Oryctes nasicornis*, &c.) are (*a*) very soft, and break up most readily into bundles of fibrils, which are surrounded by an extremely abundant intermediate substance of a somewhat fatty nature with "interstitial granules," probably with a nutritive function. (*b*) The bundles of fibrils are not only surrounded by very abundant tracheæ, but these penetrate into the bundles, and form fine ramifications round the several groups. (*c*) These fibril bundles exhibit no sarcolemma nor nuclei, and thus differ markedly from the muscle-fibres of Vertebrates. The probably rich nutritive supply afforded by the abundant interstitial substance, and the most efficient oxidation secured by the ramification of the tracheæ, are in obvious association with the high degree of activity of the wing-muscles. It is interesting that in the pulmonate spiders there are muscles very similar to the yellow thoracic muscles of insects, but differing in these important points: they include no tracheæ, the cementing intermediate substance is less copious, the transverse sections of the fibrils are much smaller, the fibrils are nucleated and apparently possess a sarcolemma.

II. *The muscles of the legs.*—Each of the muscle-fibres may be compared to a cylinder with an axial strand of non-contractile substance which is continued on all sides into extremely thin longitudinal plates, radially disposed, and extending to the wall of the cylinder. The distance between each two of these cementing interstitial substance plates is equal to the diameter of the primitive fibrils which occupy the intervening spaces in radially disposed rows. Corresponding to each of the transverse stripes the cementing plates bear ridge-like thickenings, which, in total contraction, appear as rows of spots, while the intermediate substance appears as fine longitudinal connecting lines. This is in marked opposition to Retzius's description of the central protoplasmic mass as a row of cells from which fine processes radiate out on all sides, at equal distances and in parallel planes. This the author entirely disagrees with. Deviations of detail in other insects are noted. Herr v. Limbeck refers in a postscript to an overlooked note by Rollet in the 1884 volume of the same Transactions as that in which his own paper appears. This note refers to the above differences between thoracic and leg muscles.

Halobates.*—From his investigations into the structure of *Halobates*, Dr. E. Witlaczil is inclined to differ from the view of Mr. Buchanan White who regards the genus as representing a very primitive form ; Dr. Witlaczil bases his objection on the fact that *Halobates* agrees in its internal structure with other Hemiptera, so that it must be regarded not as a trunk-form, but as a type a good deal altered by adaptation to its life in water; thus it has lost its wings, and the development of the musculature which serves

* Zool. Anzeig., x. (1887) pp. 336–9.

for the movement of the two long hinder pairs of legs, has brought about the great development of the thorax.

Cecidia caused by Nematus capreæ.*— Herr M. W. Beyerinck has a notice of the gall produced by *Nematus capreæ* on *Salix amygdalina*. The production of the gall is undoubtedly due to the matter secreted by the poison-gland, which is, consequently, homologous with the poison of Hymenoptera aculeata; when the insect does not deposit an egg in the wound which it makes the quantity of albuminous matter poured out by the vesicle is always much less than when an egg is deposited; by careful observation it is possible to assure oneself that the size of the gall is always proportioned to the size of the wound and the quantity of albuminoid matter introduced. By an experiment in which the deposited egg was punctured by a fine needle it was shown that the gall is due to the parent and not to the egg; but, of course, in such a case the gall remains small; neither the egg nor the larva are necessary for its production, though their presence exercises a certain influence on the regularity of the development.

The author has endeavoured to discover whether there is any persistent alteration in the protoplasm of the plant or not. If we suppose that the substance implicated in the substance of the gall is, like the protoplasm of the plant, a living body able to grow indefinitely, or a substance which impresses a persistent modification on the protoplasm of the plant, we ought—if we should succeed in pushing the development of the gall as one of its parts beyond the stage at which it ordinarily stops—to find that the characters of the gall remain invariably the same. If, on the other hand, the gall-forming matter cannot either grow itself nor form a new protoplasm capable of reproduction, we ought—under similar circumstances—to find the characters of the organ, whence the gall was developed, reappear. Experiment has shown that the second is the condition which obtains; a normal leaf modified by the gall-forming material grew into a normal leaf, and a root into a root.

The galls of *Nematus* are possessed of extraordinary vitality; those of *N. capreæ* are found living long after the leaf is dead; *N. viminalis*, which is found on *Salix purpurea*, exhibits really remarkable properties; although abandoned by their inhabitants at the beginning of autumn and being surrounded by damp mould during the winter, they not only remain perfectly turgescent, but some of them are able, in the following summer, to begin a new life. Galls cannot be inherited. The specific material secreted by *Nematus capreæ*—and what is true of it is probably true of other forms—is an albuminoid substance which acts as an enzymatic body.

Honeydew of Coccidæ.†—Mr. W. M. Maskell describes the organ of secretion of honeydew in Coccidæ. While examining a specimen of *Ctenochiton elæocarpi* Maskell, he noticed the sudden protrusion of an organ from between the two dorsal abdominal lobes, and the excretion of a drop of honeydew. The insect exhibits at the abdominal extremity a deepish narrow cleft on the dorsal side of which are two rounded triangular protruding lobes lying in the shallow groove formed by the sides of the cleft. From beneath these lobes the insect rapidly protrudes a cylindrical organ, composed of a basal thickish tube, bearing at its extremity another similar, but much thinner. When this organ has been pushed out to its full extent, a minute globule of the sweet fluid appears at its tip, expands rapidly, bursts, and falls in fine spray on the leaf. The organ is then rapidly withdrawn.

The author has described similar organs, without recognizing their

* Arch. Néerland. Sci. Exact. et Nat., xxi. (1887) pp. 475–92.

† Trans. New Zealand Inst., xix. (1886) pp. 41–5 (1 pl.).

function, in the second female stage of *Cœlostoma zælandicum*, and in the adult female of the same insect.

Mr. Maskell hardly believes that the liquid serves for food for the numerous dipterous and hymenopterous insects often found on the leaves among the Coccids. The organ is only now and then exserted, not constantly protruded as in Aphides.

The honeydew excreted in drops or spray by Aphides, Psyllidæ, Coccidæ, and others, forms a glutinous medium well suited for the growth of fungoid spores. The black coating often observed on leaves, especially on the lower ones, is due to a closely woven covering of fungus. Among these fungoid growths, to which Signoret gave the name of fumagine, and which Comstock calls *Fumago salicina*, a good many Hyphomycetes and Physomycetes may be found. It is a secondary, not a primary disease, and sulphur and such-like are only at best superficial remedies.

γ. Prototracheata.

Peripatus of British Guiana.*—Mr. W. L. Sclater gives a notice of a species of *Peripatus* from British Guiana which is unlike any yet named, but appears to be the same as one noticed by Prof. Jeffrey Bell from Dominica; both have refrained from giving a name to or a full description of the species, as they hope it will be described in Mr. A. Sedgwick's forthcoming monograph. We may note that Schmarda's species from Quito is not, as it should have been, enumerated, nor does Mr. Oakley's paper on *P. capensis* appear in the bibliographical list.

δ. Arachnida.

Homologues of Arachnid Appendages.†—Herr A. Lendl has studied the development of *Epeira diademata* with reference to the much discussed problem of the homologies of the appendages. The general conclusions of his investigation are as follows:—(*a*) The first pair represent antennæ; so their origin, position, motion, jointing, and innervation from the supra-œsophageal ganglion suggest. (*b*) The small tubercles under the upper lip do not in the adult look like mandibles, but this is more evident in their relatively less reduced embryonic state. In their origin, and in the connection of their ganglia with the œsophageal ring they resemble mandibles. (*c*) The import of the next pair (maxillæ) is evident. (*d*) The prosternum is no lower lip, but a portion of the sternum supporting the mandibles. No lower lip is discoverable, but the first of the four pairs of legs represent the second pair of maxillæ in insects. Their modification into ambulatory legs is no argument against this. In the first pair also the palp tends to predominate.

Astacus fluviatilis ..	Antenna I.	Antenna II.	Mandibula	Maxilla I.	Maxilla II.	Pes max. I.	Pes max. II.	Pes max. III.	Pedes abdom.
Epeira diademata ..	0	Antenna	(Embryo) Mandibula	Maxilla	Pes I.	Pes II.	Pes III.	Pes IV.	0
Carabus cancellatus ..	0	Antenna	Mandibula	Maxilla I.	Labium inf.	Pes thorac. I.	Pes thorac. II.	Pes thorac. III.	0

* Proc. Zool. Soc. Lond., 1887, pp. 130-7.

† Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp 95-100.

Interesting New Mite.*—Herr L. Karpelles discusses a new species of mite (*Tarsonemus intectus*) which occurs on barley, and seems to have been imported from Bulgaria to the neighbourhood of Budapest. It has a twofold interest, in the first place as the cause of skin irritation and eruption upon the workers; in the second place, because the author has discovered the sexually mature forms, never before seen in this genus of pseudo-parasites.

The diagnosis of the species is as follows:—Body spindle-shaped, with a process behind the transverse groove in the male. The dorsal shield never extends over the ventral surface, except on the head of the female. All stages have a well-developed fourth pair of feet. The first joint of the third pair of appendages on the male bears two protuberances. In the male the first, in the female the second pair of feet bears an attaching lobe, which is smaller than that on the other legs.

Herr Karpelles draws the following general conclusions from his study of this mite:—(1) The mites previously described as species of *Tarsonemus* are really so, in spite of Haller's opinion. (2) Among these there may have been sexually mature forms, since the external genital organs of the female are not noticeable, and since those of the male, hitherto overlooked, are protrusible structures situated on the two last segments. (3) Presence or absence of tracheæ in parasitic Acarids is not a character of much import. (4) Dermaleichidæ, with the much modified Listrophoridæ and Myocoptidæ are the nearest relations of the genus *Tarsonemus*, which appears to unite them with *Myobia.* (5) The male of *Tarsonemus* is not only the more persistent form, but that which, on account of the structure of its fourth pair of legs, is more especially parasitic. As the oral structures of both sexes are similar, the above pair of appendages must be of most importance in causing the skin eruption on man. (6) Berlese notes *Tarsonemus* to illustrate his statement that dimorphism should be excluded from among the characters of the fully developed animals. The author maintains that dimorphism is here characteristic of the mature adults. (7) *Astoma* (also *Atoma*) *parasitica*, the larva of a species of *Trombidium*, is a most striking example of the segmentation of the posterior portion in mites, for both dorsal and ventral surface exhibit four grooves or constrictions. A bibliography is appended.

ε. Crustacea.

Green Gland of the Crayfish.†—Herr B. Rawitz communicates an account of the histology of the crayfish's green gland, which has been the subject of repeated but yet incomplete investigation. A brief critical account is given of the observations of Leydig, Huxley, Wassiliew, Grobben, and others.

The gland has "the form of a mallow fruit," and consists of three very different substances, the green, the white, and the yellowish-brown. The green substance forms a kind of shell, in which the two others rest. It is thus most developed ventrally, and only a narrow fringe of it is seen on the dorsal surface. The white substance is the largest, it extends over the green, and is alone in connection with the sac. The yellowish-brown substance has a rounded conical form, lies upon and within the white, extending downwards within it to about two-thirds of the entire thickness, and occupying about a fourth of the transverse, and half of the oral-aboral diameter. It is not connected with the green substance. The terms

* Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 45–61 (1 pl.).

† Arch. f. Mikr. Anat., xxix. (1887) pp. 471–94 (2 pls.).

"lobe" (Läppchen) and "terminal sack" (Endsäckchen) applied to it by Wassiliew and Grobben are misleading.

The green substance consists of generally homogeneous cells, with a delicate contour, a well-defined nucleus, one or more pigment globules, which in some cases collect and escape at one pole. They closely resemble similar globules found in the white substance. They are apparently a secretory modification of the protoplasm. The cells are very readily broken; liberated nuclei occur all over the preparation, and exhibit among the numerous granules two or three sharply defined "nucleoli." The very delicate cell-membrane can only withstand dilute acetic acid. The green substance does not exhibit "the small blind sacks" which Huxley describes. Nor is there any hint of a cuticle formed by the cells, as Häckel, Grobben, and Wassiliew assert. Nor does the epithelium of either white or yellow-brown substance exhibit any such structure. The cells of the green substance are, however, seated on a fine, delicate, nucleated tunica propria. The lumen of the tube forming the green substance is either empty, or filled with a peculiar meshwork arising from the protoplasm of the modified surrounding cells. The various coils of the tube are separated by connective tissue, which bears vessels, and includes cavities which appear to contain blood-corpuscles. In some cases Herr Rawitz detected cells which seemed to him to be ganglionic.

The white substance is characterized by the absence of the green pigment, and by the glancing appearance of the epithelium. The cells generally resemble those of the green portion. Two different regions can be distinguished, (*a*) that which forms a continuation of the green substance, and (*b*) the terminal portion—the white substance proper. The epithelium of the former is very characteristic. The cells appear to consist of two portions—the basal and larger taking up a varying amount of stain, the other remaining colourless, but bounded towards the lumen of the tube by a very narrow fringe of stained protoplasm. The nucleus lies in the stained portion, and in such a way that the pole turned from the tunica propria exactly marks the boundary between modified and unmodified protoplasm. The epithelium of the white substance proper has a quite different appearance. The cells are flatter, the protoplasm without differentiation, the nuclei elongated oval, the limits of the cells obscure. The disruption of epithelium noted above in the green substance never occurs in either of the other portions. The connective tissue between the adjacent coils of the tube is less developed than in the green substance; it is reduced to narrow strands; the nuclei are smaller and scarcer; the presence of blood-vessels is at least doubtful.

The yellowish-brown substance owes its colour, not as Grobben reports, to a deposition of irregular bodies of a yellowish-brown colour in the protoplasm, but to the presence of more or less intensely straw-coloured nuclei. These coloured nuclei are, however, in the minority; in most of the cells the nuclei are colourless. Otherwise the cells resemble those of the green substance. As in the latter, numerous elements occur containing abundant glancing globules. These are in all probability the result of secretion. The green and the yellowish-brown portions thus agree, and together differ from the white portion. The connective-tissue and contained vessels are very sparsely developed.

The secreted products found in the white portion are round dull globules, with a sharp contour, and transparent homogeneous appearance. They occur singly or in groups. Of rarer occurrence, are club-shaped products, sometimes of very considerable size. They then exhibit a double contour, a yellowish-green colour, and a brighter well-defined spot in their expanded

region. On the smaller of these, four regions—head, neck, body, and foot, can be distinguished. These are alternately dark and clear. Long cylindrical bodies (sometimes with a lateral protrusion), of a pale colour, delicate contour, and with an internal clear spot also occur. They recall the albumen cylinders found in the urine of nephritis patients. The yellowish-brown substance also occasionally secretes irregular purple bodies with an internal clear spot.

General structure.—From his investigations Herr Rawitz has come to the conclusion that the green gland consists not of one much-coiled tube, but of two, which are only united just before the entrance to the sac. Of these the longer forms the green and white substance, while the second forms the yellow-brown substance and a small portion of the white. There is never any direct communication between the green and the yellowish-brown portion. As to *function*, the author thinks that as yet, in the absence of more complete physiological investigation, it is premature to say that the green-gland of the crayfish functions as a kidney.

Castration of Decapodous Crustacea by parasites.*—Prof. A. Giard describes the effects produced by the parasitic *Phyxus paguri* on the external sexual characters of *Eupagurus.*

The normal male hermit crab differs from the female in the arrangement of the abdominal appendages, amongst other things; but when infested by *Phyxus*, the male *Eupagurus* presents a similarity, in size and number of its abdominal appendages, to those of the normal female. The testes are filled with imperfect spermatozoa. Curiously enough, *Peltogaster paguri* produces no such effect on the male *Pagurus*, although rendering it sterile; but the females have their abdominal appendages modified in the direction of a normal male.

The author believes that *Peltogaster* fixes itself to its host at a later period than does *Phyxus*, rather than that the activity of the former is slower than that of the latter. Moreover, *Phyxus* attacks its host at a time when the embryonal abdominal appendages are still present. He considers that the Rhizocephala "have, in the phylogenetic series, introduced the Bopyrids into the Decapoda; the Isopods, originally parasitic on the Rhizocephala, at first infected the higher Crustacea through these, but later became parasitic directly on them."

Prof. Giard has seen only one specimen (from Naples) of *Gyge branchialis* infected by a Bopyrid: this is a male, which possesses the simple first abdominal appendages characteristic of the normal female. The Brachyura, infested by *Cepon*, and *Porcellanus longirostris*, infested by *Pleurocrypta porcellanæ*, show no appreciable modification of external sexual character.

Vermes.

a. Annelida.

Development of Ovum of Hirudinea.†—Herr C. Chworostansky finds that the wall of the ovary of *Hirudo* and *Aulastoma* consists of the outer membrane of connective tissue with a quantity of blood-vessels, a muscular layer which forms a plexus, and the internal cellular layers found by Iijima in *Nephelis;* the last is lined by flat epithelial cells. The blood-vessels form various stages towards Lankester's vasofibrous tissue; the muscles are either broad with a thick clearly visible plasma and a central finely granulated plasma with large elliptical nuclei, or they have no distinctly granular plasma and their nuclei are small. There are two cords; the end

* Comptes Rendus, civ. (1887) pp. 1113-5. † Zool. Anzeig., x. (1887) pp. 365-9.

of the one which is turned towards the tip of the ovary is pyriform, and its walls consist of a delicate wall with flat epithelium; the cords either float freely in the fluid or remain attached to the point where they were developed. In addition to these ovarian cords there are in the ovary three kinds of free cells, some of which have a distinct nucleus, while in others the nucleus is not stained by carmine, and yet others are degenerate egg-cells. The first form of cell is developed by the internal cellular layer enlarging into the interior of the ovary, and in these processes one or two nuclei become apparent; there are a number of intermediate stages between these and the second kind of cell, and it seems certain that the two kinds differ only in size and in the possession of a nucleus. In the degeneration of egg-cells the yolk-mass disappears, the nucleus and nucleolus alone remaining.

The formation of the germogen is effected in the following manner: the cells of the sub-epithelial layer, after growing into the interior of the ovary, lose their contour, and their nuclei divide. These form the protoplasmic matrix in which the nuclei of the primitive cells are inclosed. During the growth of the germogen the connective-tissue makes its way inwards. In *Hirudo*, *Nephelis*, and others the formation of eggs begins when these cells have developed into egg-cells; at first the egg-cells are all of the same size, but later on some grow faster than others, and the latter diminish in size. In the egg-cells nuclei, with connective-tissue filaments, make their appearance, the filaments being developed when the germogen is converted into the cord.

New Genus of Lumbricidæ.*—Mr. F. E. Beddard describes the type of a new genus of Lumbricidæ from British Guiana, which he proposes to call *Thamnodrilus gulielmi*. It appears to be most closely allied to the South American genus *Anteus* by the absence of dorsal pores, position of the nephridiopores, and in the presence of a single pair of spermathecæ in the seventh segment. In both genera the setæ are similarly disposed, and are in the region of the clitellum, where the setæ are specially modified, and resemble those of *Urochæta* in form, differing, however, in the fact that both ventral and dorsal setæ are modified. The nephridia are differentiated into three series, the first of which is represented by one pair. Each gland here consists of a flattened mass of glandular tubules; in the second set, of fourteen, the glandular part of the nephridium is very slightly developed in comparison with the extremely elongated muscular sac which communicates with the exterior. In the remaining nephridia the muscular sac is provided with a diverticulum, which is nearly as long as itself. The chief points of difference between *Anteus* and *Thamnodrilus* appear to be the much greater extent of the clitellum in the former, the thickening of its anterior mesenteries, and the special modification of the nephridia of its genital segments. The representatives of this new genus are about 6 inches long and 3/8 inch broad.

Ctenodrilus parvulus.†—Dr. R. Scharff describes a new species of *Ctenodrilus* lately found by Mr. Bolton in his sea-water aquarium. It is of remarkably small size, being only about 4 mm. long, and having from seven to ten segments. It agrees with *C. pardalis* in having dark green or violet spots in the skin. The number of bristles in each of the two rows of either side is subject to great variation, and they cannot therefore be used for diagnostic purposes. The "segmental organs" are found in the head segment only; the dorsal blood-vessel is found only in the three anterior segments.

* Proc. Zool. Soc. Lond., 1887, pp. 154–63.
† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 591–603 (1 pl.).

Beneath the epidermis there is one very thin muscular layer, which consists merely of the primitive longitudinal fibres which stretch uninterruptedly from head to tail. The segmentation of the alimentary canal appears to be independent of that of the body generally. With regard to the limitation of the "segmental organs" to the head, it is of interest to be reminded that a similar condition obtains in the larva of *Polygordius*.

The entire length of the nervous system lies in the epidermis. It consists of a cerebral ganglion and two commissures, which pass to the ventral surface, where they unite to form the nerve-cord; as in *Halicryptus* and *Priapulus* epithelial and ganglionic cells seem to merge into one another. No peripheral nerves were seen; the only sensory organs are two small ciliated pits, one on either side of the cerebral ganglion. No traces of reproductive organs could be found, but there is fissiparous reproduction, similar in character to that described by Kennel for *C. pardalis*. As in it, almost every segment becomes a zooid, which rapidly developes into the multisegmented form; a bud appears between two segments, and the buds are produced in the same order as new segments, i. e. from before backwards. As is well known, in Naids, the buds appear in the opposite order, and on this Semper's "proglottidentheorie" is based; but it is clear that it will not apply to *Ctenodrilus;* differentiation of the budding zones, unlike, again, what happens in Naids, does not go far until division of the animal. In all observed cases the act of fissiparous reproduction of *C. parvulus* was completed within forty-eight hours. *C. monostylos* differs in that there is no appearance of buds, the animal merely breaking up into two almost equal parts, each of which may again divide into two or more parts.

Natural History of the Genus Dero.*—Mr. E. C. Bousfield gives a history and bibliography of this genus, with notes on their habits and the nature of their tubes, with some hints as to the methods of observation. A description of the general character is succeeded by a more detailed account of the branchial apparatus.

The author regards the "segmental organ" as purely mechanical in function, in "preventing undue distension of the body by the fluid which passes through the walls of the intestine, and is doubtless charged with effete material from the blood-vessels which run in contact with it." Moreover, what is generally considered to be the movement of cilia in these organs he maintains to be due to the vibration of a membrane, the free edge of which can be seen when vitality is at a low ebb. Observations on *Tubifex*, *Nais*, *Stylaria*, and *Ælosoma* lead him to this view. The sessile habits of *Dero* necessitate some greater opportunity for oxidation of the blood than is provided in other worms by the current of water which is continually flowing in at the anus. The form of the branchial area varies in the different species, but there are never more than four branchial processes.

A systematic description is given of the asexual forms of the seven known species.

Histology of the Integument and Sensory Appendages of Hermione hystrix and Polynoe Grubiana.†—M. C. Jourdan gives an account of the dorsal cirri of *Hermione hystrix*, which seems to show that these organs are tactile. Owing to the movements of the parapodia with which they are connected they are able to exercise true tactile functions. The nerve which passes to them enters into communication with the exterior at the level of the pores, and there is a richness of innervation and a frequency of connection with the epithelial elements which shows well the specially sensory

* Journ. Linn. Soc. Lond., xx. (1887) pp. 91–106 (3 pls.).
† Arch. Zool. Expér. et Gén., v. (1887) pp. 91–122 (2 pls.).

functions of these small organs. The existence of a small accessory ganglion is of some interest, for it supports the view of those histologists who believe that every sensory nerve-ending is accompanied by ganglionic cells. The elytra are not active organs of touch, but they possess a much greater general sensibility than the ventral integument, for they contain a very rich nervous plexus, and the epidermic cells are at certain points in direct contact with the external medium. On the ventral surface tactile sensations appear to be localized in the spherical wart-like projections which are found on the integument, but they must not be supposed to be seats of "active sensation." The subepithelial nerve-plexus is connected with nerves of some size, which arise from the nerve-chain in each somite; these nerves are composed of fibrils remarkable for their delicacy. The muscular fibres, and especially those which belong to the system of longitudinal muscles, are remarkable for the irregularity of their forms; some of them are composed of two swollen extremities connected by a constriction of varying length, their fibres are neither transversely nor longitudinally striated, and they are irregularly cylindrical; they appear to be entirely composed of a contractile substance, which stains an orange-yellow with picrocarmine.

The elytra of *Polynoe Grubiana* contains a nerve-plexus analogous to that which is found in the elytra of *Hermione*, but the dorsal cirri differ a good deal in their general structure. The tactile functions are exercised chiefly by the terminal segment, and the tactile powers of the stem of the cirrus, which are so well developed in *Hermione*, are here much reduced; the presence of a large number of large glandular cells on the basal joint gives a peculiar aspect and function to these appendages.

Chloræma Dujardini and Siphonostoma diplochaitos.*—M. Joyeux-Laffuie cannot agree with M. Künstler in thinking that *Chloræma Dujardini*, which attains a length of 15–20 mm., can be the same animal as *Siphonostoma diplochaitos*, which is about 8 cm. long.

β. Nemathelminthes.

Tylenchus devastatrix.†—Herr T. Ritzema Bos gives a preliminary account of the structure, habits, and practical import of the nematode *Tylenchus devastatrix*, which is a too abundant cause of disease in rye. He is about to publish a complete account of his investigations in monographic form.

The first part of his paper is occupied with a history of previous investigations relating to the genus *Tylenchus*. He reviews the various forms of *Tylenchus* which have been described, and discusses them in relation to the diseases which they occasion in numerous plants. *T. devastatrix* may live on very different cultivated plants. *Tylenchi* which have been restricted for generations to one kind of plant come to differ in form and size from the same species on other plants. With them as with other parasites, slight changes appear in response to different environment. The author suggests that the free-living *T. intermedius* of de Man is the original species of which *T. devastatrix* Ritzema Bos (*T. dipsaci* Kühn + *T. devastatrix* Kühn + *T. askenasyi* Bütschli + *T. hyacinthi* Prillieux + *T. Lavensteinii* Kühn + *T. alii* Beyerinck) is only an adaptive modification.

T. devastatrix inhabits only stems and leaves, never roots. It infests certain plants specially (rye, onions, hyacinths, teasel, &c.), and causes disease. It occurs in many others, but without doing much damage. It has been recorded in 34 species, representing 14 different families of plants.

* Comptes Rendus, cvi. (1887) pp. 179–80. † Biol. Centralbl., vii. (1887) pp. 232–43.

Even in infested ground certain plants remain free. Slight differences in thickness of cell-wall, &c., mean much to the parasite. A detailed tabular survey of its relation to numerous plants is given. The persistence of *Tylenchus* for generations on one kind of plant may to a certain extent unfit it to attack another; the difference resulting is rather physiological than morphological. Just as Bacteria morphologically the same are often very different physiologically, so with *Tylenchi;* and just as a *Bacterium* may have its virulence attenuated by a given culture, so *T. devastatrix*, as far as hyacinths are concerned, may be said to be attenuated by culture for several generations on rye.

Although the *Tylenchi* are true plant parasites, it follows from the nature of most of the plants which they infest that they spend part of their life in the ground. It is different, however, with those infesting hyacinths and bulbous stems. In spring these usually migrate from bulb to leaves, retiring again to the bulb as the leaves die off. They pass from old bulb to young bulb, and thus never enter the ground. The "rye-worms" pass from the soil into the young plants, remain there and multiply till the grain ripens and the stem and leaves begin to wither. Then they retire to the soil again. The life-history varies with the plant infested. They may remain a long time, over a year sometimes, latent in the ground, probably in a lethargic state, but this can only occur in the upper drier layers of the soil.

γ. Platyhelminthes.

Relation of the Nemertea to the Vertebrata.* — Prof. A. A. W. Hubrecht devotes his memoir on this subject to the establishment of the following proposition :—" More than any other class of invertebrate animals the Nemertea have preserved in their organization traces of such features as must have been characteristic of those animal forms by which a transition has been gradually brought about from the archicœlous Diploblastic (Cœlenterate) type to those enterocœlous Triploblastica that have afterwards developed into the Chordata (Urochorda, Hemichorda, Cephalochorda, and Vertebrata).

In support of this proposition it is pointed out that the Nemertea present the following Cœlenterate characteristics : the presence of nematocysts in the proboscidian epithelium, the elaborate nerve-plexus in the integument and its histological features, the presence of epiblastic muscle-fibres separate from the general body-musculature, the presence and the chemical constitution of a sometimes very massive intermuscular jelly by which the other organs are at the same time surrounded, the mode of development of the mesoblast (at least in *Lineus obscurus*), which is less specialized than in most other Invertebrates, and lastly, the absence of any distinct enterocœle. The following, on the other hand, are the points of resemblance to the Chordata; the general features of the nervous system, the presence of a homologue of the hypophysis cerebri as a massive and important organ (the proboscis), the presence of tissues which may have become converted into the notochord (viz. the material of which the proboscidian sheath is built up), and the respiratory significance of the anterior portion of the alimentary tract.

Prof. Hubrecht's speculations are based on the conviction that new combinations or organs do not appear by the action of natural selection unless others have preceded, from which they are gradually derived by a slow change and differentiation.

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 605-44 (1 pl.).

With regard to the resemblances between vertebrate and invertebrate nervous systems, we must for the present be content with general points of coincidence, and must rigorously refrain from detailed comparisons. If we take the Nemertean arrangement as our starting-point, it is easy to understand the polymerous root of the vertebrate vagus and its mixed physiological duty. The author enters at some length into a comparison of the Chordate and Nemertean nervous systems. The origin of metamerism is looked for in the dangers to the rupture of individuals and their counteraction by regenerative processes.

Spermatogenesis in Nemerteans.*—Mr. A. Bolles Lee communicates an account of the spermatogenesis of nemerteans, especially of *Tetrastemma melanocephalum*. His research has special reference to Sabatier's theory of spermatogenesis. According to Sabatier the primitive "male ovule" developes on its surface a number of "protospermoblasts" round a degenerating (female) core, the "protoblastophore," and in each of the protospermoblasts the same process is repeated in the development of a second generation of centrifugal elements—the "deutospermoblasts" which are disposed around the central core or "deutoblastophore." This account the author was entirely unable to verify.

He is inclined to believe that the male elements have their primary origins from mesodermic tissue, and not, as Hubrecht maintains, from the ectoderm. (1) What Sabatier has described as a mass of non-nucleated protoplasm, was the first certain trace of the male elements recognized by Bolles Lee. But when this apparently homogeneous content of a sperm-sac was fixed, stained, and sectioned, it was found to consist of a mass of distinctly nucleated cells. (2) At a later state a median section of one of the lobes of a sperm-sac exhibited from the periphery centralwards, the following series of cell groups:—(*a*) One or two layers of large pale cells, distinctly separate, with pale nuclei; (*b*) a much larger region with smaller, more crowded cells, with more distinctly chromatic nuclei, and more or less regularly linked together by strands; (*c*) within this spermatozoids, more or less adherent, with their heads towards the periphery and their tails in the lumen. This appearance is interpreted as a succession of spermatogonia (S^1), spermatocytes (S^2), spermatides, and spermatozoa from the periphery inwards.

(3) The author next discusses the minute characters of these different stages which were studied in preparations fixed with osmic acid vapour. The elements S^1 are typical cells; no trace of karyokinesis was seen; but traces of binary division and certain indications of endogenous multiplication were observed. The elements S^2 are much smaller, but distinctly cellular, with very thick nuclear ribbon, either uniform or necklace-like. Some of the dispositions suggested very simple karyokinetic division. They also multiply by endogenous division. The spermatides are at first very small, but seem to increase notably in size before becoming spermatozoa. They have a cellular membrane, but only a minimum of protoplasm. Neither here nor in S^2 was a nuclear membrane demonstrable. The changes of the nucleus, the appearance of the accessory body or "Nebenkern," the formation of the tail and other modifications in the ontogeny of the spermatozoid are then discussed. Young sperms were seen swimming about with a suspended vesicle, the remnant of the cell-membrane containing a homogeneous substance, and sometimes the "Nebenkern" intact or in process of dissolution. The author believes that the membrane is not

* Rec. Zool. Suisse, iv. (1887) pp. 409–30 (1 pl.).

thrown off, but utilized. Occasionally the pseudopodic process, characteristic of the spermatide, persists in the spermatozoa.

All nemerteans observed exhibited the same mode of spermatogenesis. This mode is general and typical among animals. Sabatier's account obviously does not in any way conform with the facts above summarized.

Anatomy of Langia obockiana.*—Dr. L. Joubin gives an account of a new species of Nemertean from Obock. When alive it is about 30 cm. long, and is of a carmine colour; along the whole length of its body there extends a deep dorsal groove, bounded by two pads which are generally approximated to one another, but can be separated so as to widen the groove; the floor of this groove is provided with longitudinal folds; the hinder end tapers gradually. The head is of a somewhat remarkable shape—the end is a little pointed, and it then suddenly swells and becomes very wide; it is divided into four by two lateral grooves, and by a less marked ventral, and a deeper dorsal groove; it is sharply marked off from the rest of the body, both by its clearer hue and by a large and wide groove which forms a kind of neck.

When the grooves are studied in section they are seen to be lined by a continuation of the reflected skin; at the floor the epithelium is higher, and rests on a hyaline layer. Beneath this, in the midst of the plexuses of subcutaneous connective tissue there are large elongated cells arranged radially around the floor of the cul-de-sac; the prolongations of these cells traverse the hyaline layer and penetrate into the interior of the epithelium; these are clearly nervous, and may be regarded as ganglion cells, which are connected with the nerves that arise from the brain.

The skin presents the same histological characters as that of the Nemerteans, and especially of the Schizonemertini; and the same is true of the musculature.

The digestive apparatus is interesting, inasmuch as it is extremely developed in relation to the general proportions of the animal, the lateral pouches being extraordinarily exaggerated, and the true digestive tube being limited to a kind of central passage which merely connects the lateral pouches. The cæcal pouch in front of the mouth is very large, being nearly 5 mm. in length, and the mouth appears to be a hole in the wall of the œsophagus, which extends above and below it. The œsophagus itself is completely invested in a circular layer of muscular fibres which form a kind of elastic sheath to it, and must have an action on the deglutition of food. Two thick layers of lamellæ extend into the lumen of the true digestive tube and considerably diminish its capacity; they consist of a delicate layer of connective tissue covered by epithelium, which was, clearly, ciliated.

Not far from the commencement of the intestine, and behind the œsophagus, there are two opposite and parallel grooves of no great length, which possibly serve as gustatory organs. The proboscis was very delicate in proportion to the diameter of the worm; its orifice was not at the exact anterior point of the body, but a little below it, and was so arched as to reach to the median part of the cephalic region, where it was lodged in the midst of a sinus.

The circulatory apparatus of *Langia obockiana* differs only in some details from that of *L. formosa*, lately described by M. Oudemans; nor does the nervous system differ in any important characters from that of other Schizonemertini, as described by Prof. Hubrecht. No trace of sexual organs was found in the specimens which were taken in February 1886.

* Arch. Zool. Expér. et Gén., v. (1887) pp. 61-90 (2 pls.).

Development of Fresh-water Dendrocœla.*—M. P. Hallez gives a notice of his observations on the early stages of the development of fresh-water Dendrocœla. The ova, in the ovary, are not spherical, but have a long axis parallel to the longitudinal axis of the Planarian, and they are alecithal. Impregnation is effected in the uterus; when the eggs descend into the genital cloaca they become surrounded by about twenty vitelline cells, arranged radially. M. Hallez thinks that his observations are sufficiently numerous to justify him in denying the presence of polar globules. The following are the changes undergone by the nucleus; the filaments of chromatin are at the periphery, they become arranged on an equatorial plane, they separate and form a wedge whose axis runs along that of the egg, the wedge being formed of eight meridian filaments of chromatin; the filaments then become more delicate and separate at the equator, they then become drawn towards the poles, and afterwards become sinuous.

As far as the 8-stage the blastomeres are equal; after it the radial vitelline cells begin to shed out a finely granular protoplasmic substance which filters between each of the blastomeres and forms a special medium for it. In the later stages the segmentation cavity becomes filled by this fluid, which goes on increasing as the blastomeres multiply. When the cells which have primitively surrounded the egg have disappeared, those which are nearest the embryo come to their aid, and take their place; the homogeneous mass can only be considered as a medium, for it takes no part in the formation of the embryo.

Helminthological Observations.†—Dr. F. Zschokke examined, during his stay at Naples, 72 species of fishes, of which 53 were infested with parasites. Of 257 fish only 73 were quite free. Parasites are more common in Selachians than in Teleosteans. 77 species of parasites were found: 38 Cestodes, 16 Trematodes, 3 Acanthocephali, and 20 Nematodes. The first were found almost exclusively in Sharks and Rays; of 4 species the larval stage was found in Teleosteans, and the adults in Cartilaginous fishes. The Nematodes were more common in bony fishes. The author cannot agree with Dr. Oerley's generalization that a striking peculiarity of Selachian Cestodes is their small size, or that the length of the parasite is in inverse relation to the size of its host.

δ. Incertæ Sedis.

Ectoparasitic Rotifers from the Bay of Naples.‡—Dr. L. Plate gives an account of the Seisonidæ, of which as yet only two genera, *Seison* and *Saccobdella*, are known. A new (third) genus is now formed, which it is proposed to call *Paraseison*. There is no hindgut in either sex. The wheel-organ may be reduced to a few tactile setæ. There are two flask-shaped glands in the hinder part of the head. The gonads are placed laterally or dorsally to the stomach. The ductus ejaculatorius of the male has smooth walls, and there are numerous flask-shaped spermatophores. There is no sucking disc to the tail, but the hinder pole of the body has the form of a hemisphere, which is beset with a row of small denticles, among which the attaching glands open. Four species of this new genus are described, under the names of *P. asplanchnus*, *nudus*, *proboscideus*, and *ciliatus*.

As will be seen from the above account, *Paraseison* differs from *Seison* in a number of details, but is at the same time clearly a close ally. The relations of the two to *Saccobdella* cannot, with our present slight knowledge of the third genus, be exactly defined.

* Comptes Rendus, civ. (1887) pp. 1732–5.
† MT. Zool. Stat. Neapel, vii. (1887) pp. 264–71.
‡ Ibid., pp. 234–63 (1 pl.).

The author has recently shown that the fresh-water Rotatoria fall into the two natural divisions of Ductifera and Aductifera, and into these fall also a number of marine forms. For the parasites of *Nebalia*, a third family, which may be called that of the Seisonidæ, must be instituted. It stands nearer the Philodinaidæ than the Ductifera. As the former appear to present the most primitive arrangement of the wheel-organ, it may be supposed that the Seisonidæ branched off early from the root of the trunk of the Rotatoria. The most primitive arrangement of the sexes was a double one, and the bisexual character of most members of the class must be regarded as having been secondarily acquired. The only difficulty is presented by the masticatory organs, which in the Seisonidæ are closely of the type which obtains in the Ductifera, and different from what are seen in the Philodinaidæ. The author is inclined to explain this by supposing that the masticating apparatus of the Archirotator as seen in the Philodinaidæ was lost, and that a fresh and independent development obtained in the two different divisions.

Myzostoma Bucchichii.*—Dr. F. v. Wagner describes, from a single specimen dredged off Lesina, a new species of *Myzostoma*, which he calls *M. Bucchichii*. As *Antedon rosacea* was also dredged in the neighbourhood, the author thinks it may be one of the parasites of that Crinoid. The disc is about 3 mm. in diameter, and the new species is characterized by the tubercles which are arranged symmetrically in five groups on the dorsal surface. Each consists of an aggregation of four to seven papillæ of various sizes. The suckers are completely wanting, as in *M. folium*, *carinatum*, and *coronatum*.

Echinodermata.

Movements of Star-fishes.†—Prof. W. Preyer commences the second half of his Memoir on various Echinoderms by a discussion of the reflex movements of Crinoids. To what is known as to the function of the cirri as organs of attachment, he adds the observation that the cirri serve as organs of touch, and very probably test the surface to which they attach themselves. In any case they, like the pinnules, are distinguished by their reflex irritability. Even the larvæ are very sensitive. Strong mechanical, electrical, thermal, or chemical stimuli directly applied to the stalk easily cause the breaking off of the distal part of the rays. The pieces broken off do not merely, as Krukenberg reported, retain their reflex irritability for several hours, but rather for days. The irradiation of stimuli is clearly affected in Crinoids by very slight lesions; they are very sensitive to elevations of temperature.

With regard to the movements of escape made by star-fishes and brittle-stars, Prof. Preyer is unable to accept the exactness of the results of Mr. Romanes and Prof. Ewart. He does not find that they try to escape from the stimulus in a straight line, nor that if two neighbouring rays are excited the line of escape is the " diagonal," nor that if the tips of five rays are simultaneously excited there is a tendency to rotate round the vertical axis. When a caoutchouc ring was firmly placed round two rays of *Astropecten pentacanthus* there was no attempt made to escape, but after six days the rays were broken off. After rapid and strong compression of a ray of *Ophioderma* [*Ophiura*] it was not withdrawn every time, but was often moved in pendulum fashion without any attempt to escape. The answering movements of Echinoderms are much more complicated than appears at first

* Zool. Anzeig., x. (1887) pp. 363–4.

† MT. Zool. Stat. Neapel, vii. (1887) pp. 191–233 (1 pl.).

sight, and Prof. Preyer can only imagine that the just-named observers did not sufficiently vary the conditions of their experiments. Thus, to follow a straight line of escape is only one way among many. If a fresh *Luidia* be electrically stimulated anywhere on its back, it may escape in curved, zig-zag, or straight lines, and the latter do not by any means always lie between the point of irritation and the centre of the mouth. The same holds good for *Asterias*. *Ophioderma*, under the same conditions, makes quite irregular attempts to escape. With *Asterias* a strong stimulus is sometimes followed by no change of place, and *Luidia* often commits amputation. One of the most remarkable phenomena offered by Asterids is their attempt to escape from air. Thus, if two rays of an *Asterias glacialis* are placed in a narrow tube filled with sea-water, while the other three rays remain in the air, the latter will within ten minutes be drawn in, even though it were impossible, without breaking the animal, to force it through. This is an indication of the co-ordinated contractions of several thousands of muscles. After describing a large number of most interesting experiments, Prof. Preyer says it would be useless to describe more showing with what judgment star-fishes and brittle-stars free themselves from elastic rings, various coiled threads, nets, and so on. The certainty and even the elegance with which they act cannot but strike the observer, while again the number of superfluous twistings, tactile movements, and locomotor actions diminish the more often the creature is put to the test; the variations in the angles formed by two rays are quite astounding. The consensus of all the parts of a pentate or septate nervous and muscular system is no less interesting from a physiological-psychological point of view than the mechanism by which freedom is gained.

Dealing next with autotomy or self-amputation, the author commences by remarking that the fact of many animals being able, under certain conditions, to rid themselves of a part of their bodies is a physiological problem of the first rank. He finds that autotomy must not be ascribed to one cause only. Various observations dealing with this comparatively well-known phenomenon are detailed, and it is pointed out that in *Luidia*, at any rate, self-amputated pieces, when stimulated electrically, may break up into two or even three pieces; this shows, of course, that the central nerve-ring is in no way necessary for autotomy. The observations all together show that we have to do with a process of a special kind, and that self-amputation is not always a reflex action.

The succeeding chapter properly deals with the restoration of separated parts; after a reference to the well-known fact that pieces of star-fish with which no portion of the disc remains connected may regenerate the four other arms, it is pointed out that from a physiological point of view this fact is especially noteworthy; for Prof. Preyer has found that the central nerve-pentagon of Echinoderms, or at least its five angles, from which the radial medullæ take their origin, are functionally (so far as co-ordination is concerned) more important than the radial medulla itself; yet in these "comet" cases of reproduction the latter is alone sufficient to reproduce the central organ. We have, within a year, a central nervous organ of a high order formed completely afresh from a peripheral part of a lower order. The fact that regeneration of Ophiurids cannot be effected without the participation of the disc shows that, in them, the nerve-centre is physiologically much more important than in *Asterias*.

Although there is morphologically no essential difference in the value of the rays, it was thought important to test the question from the physiological side; a number of experiments were performed, but no ray was found to be of greater value than the rest; some interesting facts were,

however, brought out by these experiments. The animals were often seen to be in doubt as to which ray should go first; Asterids often turned on their axis before moving forwards, and the direction of the turning might be with or against the hands of a watch. There was a remarkable variation in the length of the latent period, one and the same individual giving a few seconds or an hour; in general the very long latent periods were observed after several experiments had been performed on the same individual. After amputation of one or more rays the latent period was increased.

Observations were made on the dependence of movements on sensory impressions; with regard to the influence of light, the results of Romanes are confirmed, and it was noticed that very slight differences in the illumination of the walls was sufficient to cause a movement of most Asterids (never of Ophiurids) from the less to the more brightly illuminated part. Experiments to test the sense of colour were all negative in their results; the photochemical sensitiveness of the skin was repeatedly observed, and it was found that there were colouring matters present which are sensitive to light; Asterids certainly seem to have specific nerves sensitive to luminous impressions and connected organically with the co-ordination centres.

The great sensitiveness of all star-fishes to alterations in the concentration and chemical composition of sea water shows a great power of distinguishing sensations, but the fact that any part possesses this chemical sensitiveness speaks against the supposition that there is any specific sense of taste. Experiments made along the lines of those used by Romanes on the sense of smell did not give constant results, but it is possible that the animals which failed to be attracted by the food were not hungry; the interesting and even entertaining recital of experiments shows that very complicated movements are made, and that, at least in a state of inanition, there is a great irritability of the specific olfactory nerves, and a close connection between these and the co-ordinating centres; certain olfactory impressions cause a rapid and direct movement of the whole animal to the place whence they came.

The experiments that have been recorded have, incidentally, given considerable evidence as to the presence and extent of the tactile sense.

Summing up the results of his important investigations, Prof. Preyer commences by calling attention to the proof that Asterids, Ophiurids, and Crinoids perform quite a series of movements, which cannot be of a purely reflex nature, but presuppose a certain intelligence; it has further been shown that the central or peripheral portions of the nervous system are functionally unequal in value; by means of the "ambulacral law" it is possible to say beforehand how a given star-fish will respond to various stimulations of its pedicels, and when stimulation will irradiate and when it will not. Others of the experiments add to our knowledge of the comparative value of poisons. A large series of observations have been made on the physical and psychical functions.

In the reflex retraction of the suckers we find coming into play the sensory nerve-fibres passing from the pedicels into the sensory ganglion-cells of the radial medulla, connecting fibres between these and the neighbouring motor ganglion cells, the motor fibres from the latter into the muscular fibres of the pedicels, sensory nerve-fibres from the dorsal integument into the sensory ganglion cells of the radial medulla, and, lastly, connecting fibres between the latter and the ganglion cells of the medulla. Similarly, reflex extension is effected by the action of the sensory nerve-fibres which pass from the skin of the back into the other sensory ganglion cells of the radial medulla, connecting-fibres between these and the motor

ganglion cells, and motor nerve-fibres from those in the wall of the ampullæ.

Further, it may be regarded as probable that the central nerve-pentagon has a different function at the angle whence the radial medulla arises than in the commissures; perhaps there are there a larger number of ganglion-cells; these points are distinguished physiologically by being the seat of higher psychical functions than is the radial medulla.

The explanation of the consensus which the five-rayed or many-rayed animal exhibits is, it is probable, to be explained, not by supposing there is a permanent "central soul" governing the five separate "souls," but that at one time one, and at another time another, central stimulus has the upper hand; the Echinodermata must be regarded as possessed of what is ordinarily called psychical activity—for Asterids and Ophiurids have sensation, will, understanding; what is peculiar to them is that mind or "soul" is fivefold or manifold, has five (or more) similar substrata which are in close organic connection with one another. Only so long as this nervous substratum is uninjured is the psychical activity able to act in harmonious co-ordination.

Circulatory Apparatus of Ophiurids.* — Dr. R. Koehler finds it necessary to distinguish in the circulatory apparatus of Ophiurids a vascular and an aquiferous system together with a system of perihæmal canals. The aquiferous system, the study of which presents no difficulties, consists of an oral circle provided with Polian vesicles and giving off radial trunks; it communicates with the exterior by means of the sand canal. The system of perihæmal canals consists of the oral circle, the radial canals, and a space which incloses the madreporic gland; the canals are divided by a partition into two cavities, in one of which are lodged the nerves and the vascular trunks; the radial canals give off lateral branches which open into the dorsal cavity of the arm, which is the continuation of the general cavity; and it is in this way that the perihæmal canals, which are not direct prolongations of the cœlom, and are even developed quite independently of them, communicate with the general cavity. The fluid found in this cavity contains the same elements as that which circulates in the perihæmal canals.

The vascular system presents quite special characters; instead of having a free lumen, the walls of which are lined by an epithelium forming a very definite layer, it consists of a series of formations made up by a special tissue; in this there are anastomosing fibres, in the midst of which there are developed cells whose protoplasm is charged with pigmented granulations, such as are found in the cœlom. This tissue is arranged in the form of fibres which make up the oral vascular circle, and the radial vessels; in the madreporic interradius, however, it forms an organ of considerable size —the madreporic gland. These structures are always inclosed in the schizocœlic spaces, the whole of which forms the system of perihæmal canals. The vascular system of Ophiurids may, therefore, be considered as a collection of structures differentiated within the perihæmal canals, which have a complicated structure, and form tissues of the glandular type in which there are developed elements which are analogous to those of the cœlom. It would appear then that the chief function of the so-called vascular system of Ophiurids is to produce these elements; in fact, cells with pale and irregular protoplasm are very numerous and closely packed in the central parts of the madreporic gland, where they appear to multiply actively; thence they pass towards the peripheral region, and as they do so they become charged with pigmented granulations; there is nothing to lead

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 101–58 (3 pls.).

us to doubt that they then fall into the space which extends between the gland and its envelope, and which, as has been shown, opens into the perihæmal circle; from the perihæmal circle the elements, thus formed, can easily pass into the cœlom.

If this is really what happens in the madreporic gland, the same phenomena ought to obtain, though in a much less important manner, in the other parts of the vascular system. Throughout the vascular trunk cells must be developed, which pass directly into the perihæmal canals, for the same cells and the same arrangement are found in these as in the madreporic gland.

Although it does not seem to be correct to speak of such a system as this as vascular, yet it appears to be well to retain the name provisionally, so as to design among Echinoderms generally that collection of structures which appear to be homologous throughout the group; but it must be remembered that great differences may be caused by the varying importance of different portions of the system, and by the great development in some of parts that are not present in other members of the sub-kingdom.

Leaving aside the Holothurians, the author proceeds to institute a comparison between the circulatory system of Ophiurids and that of other Echinoderms. The Asterida differ so far that the perihæmal canals, in which the different parts of the circulatory system are differentiated, communicate with other lacunæ, developed in the dorsal surface of the test, where they form an aboral ring. Owing to the situations of the madreporic plate and of the genital organs, no such system of lacunæ could be developed in Ophiurids.

In Echinoids the important difference is that the vascular trunks are placed outside the perineural spaces and do not always accompany the nervous system; the differences in the form of the vessels, and the mode of communication between the aquiferous and vascular systems are of slight importance. The arrangement of the vascular system in Echinids is too like that of Asterids and Ophiurids for us to doubt the essential homology in all these classes.

The circulatory system of Crinoids, as made known to us by the works of Perrier and of Vogt and Yung, is very different, but may nevertheless throw some light on that of the groups just considered. It has been shown that in the larva of *Comatula*, the dorsal organ gives off a bud which penetrates into the arms, and developing in the pinnules forms the sexual products; the dorsal organ is, then, a kind of central stolon, from which the gonads arise.

In Echinids and Asterids the madreporic gland becomes continuous with a circular system of canals from which branches pass off to the genital organs. The question whether we have not here indications of more close relations than have been suspected must be answered after a study of the development of the madreporic gland and the gonads of Asterids and Echinids.

Radial Symmetry of Echinoids.*—Dr. W. Haacke discusses the old question of the radial or bilateral symmetry of Echinoids. (1) He shows in the first place that it is no direct corollary of Lovén's law that these animals are really bilateral. What Lovén's researches distinctly proved was the complete homology of the parameres in all Echinoids with the exception of the Perischo-echinidæ, and that *Spatangus* has a distinct and constant median plane. But this does not prove the radial symmetry of Echinoids.

* Biol. Centralbl., vii. (1887) pp. 289–94.

(2) The second part of Haacke's paper contains an account of his studies on abnormal *Amblypneustes*,—(*a*) with four parameres; (*b*) with six; (*c*) with differentiated median planes; (*d*) with hypertrophied parameres; (*e*) with two madreporic plates; (*f*) with irregular peristomal interambulacral plates.

(3) The real question is whether the sea-urchin consists of five equivalent portions, or only of two. It is evident that in all normal cases there are five parameres, though many exhibit in the reduction of one a tendency to become bilateral. The question is arithmetical, not geometrical. Whatever be the geometric form, bilateral animals have two, and radial at least three equivalent portions. That the geometric median plane in Clypeastroids and Petalostichidæ is different from that in *Echinometra*, and that again different from the closely related *Colobocentrotus*, and that it occupies at least four different positions in *Amblypneustes* are facts not to the point. The question is arithmetical.

Only radially symmetrical animals with an unequal number of parameres greater than two, can admit of a sudden and direct increase or decrease in the number of their parameres. That is unknown in bilateral animals. Even in Clypeasters with distinct and constant median planes, the occurrence of forms with four and six rays, as noted by L. Agassiz and Desor, shows how increase and reduction may even then occur. The Clypeastroids and Petalostichidæ are just as radial as the endocyclic forms, in spite of the median plane present in the former.

But by the gradual occurrence of paired symmetry throughout the entire structure, a radial animal may become bilateral, and mutatis mutandis *vice versâ*. The difference between a bilateral with two, and a radial with three parameres, is not greater than the difference between two radially symmetrical animals with four and five parameres respectively. The distinction has in fact been unwisely exaggerated out of proportion to its real importance.

Morphological Relations of Summit-plates in Blastoids, Crinoids, and Cystids.*—Messrs. C. Wachsmuth and F. Springer discuss the views put forward by Dr. P. H. Carpenter and Mr. R. Etheridge jun. in their recent Catalogue of the Blastoids in the British Museum. The latter authors try to show that the summit-plates of Blastoids exhibit a series of variations in number and position in some degree corresponding with a similar but more extensive series of variations among the Palæocrinoidea—they both exhibit a transition from five closely united plates fully covering the summit to a set of six proximal plates surrounding a central one; the six proximal plates are regarded by Messrs. Carpenter and Etheridge as the homologues of the five oral plates of the Neocrinoidea. Messrs. Wachsmuth and Springer are, however, of opinion that the English authors have altogether failed to point out a single case in which five primary plates cover the peristome among Blastoids, and they think that the superficial resemblance in the form and position of the ventral plates of *Allagecrinus*, *Haplocrinus*, &c., with the orals of certain Neocrinoids has led Dr. Carpenter to regard them as orals. It may be pointed out that these plates agree equally well with the interradials of the Cyathocrinidæ, and that, as interradials, the genera just named do not present any exceptional type in the morphological conditions of these plates. The American critics refuse to look on the "orocentral" as being anything more than a highly hypothetical plate, and they refuse, therefore, to understand how five plates, without coming into contact with the anus, were transformed into six plates or more.

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 82–114 (1 pl.).

Synaptidæ of the Mediterranean.*—Dr. R. Semon has investigated not only the well-known *Synapta digitata* and *S. inhærens*, but also the *S. hispida* of Heller, and the first representative of *Chirodota* which has been found in the Mediterranean. A fresh systematic account of *S. hispida* is given. *Chirodota venusta* sp. n. is only found in the thick roots of *Posidonia caulini;* it differs from the Synaptæ in that the five radial nerve-trunks, after leaving the nerve-ring, pass out above and not through the calcareous ring; this new species appears to be near *C. dunedinensis* Parker.

S. digitata and *S. hispida* live on and not in the sand, and in their external appearance they mimic well the ground on which they live; in their tentacles quite a number of animal and vegetative functions are united; respiration is aided by the extraordinary lively circulation which goes on within their cavities; they serve as organs of attachment, and either draw their body towards the affixed object, or, if that be small, they draw it towards themselves, thus subserving locomotor or prehensile functions. They act also as digging organs, pushing aside the sand and so allowing of the intrusion of the anterior end; by seizing sand-grains and swallowing them they get the minute organisms which are found in the sand. Together with the tactile papillæ in the skin, the tips of the tentacles serve as organs of touch.

With regard to the development, minute structure, and morphology of the calcareous spicules, what is true of Holothurians appears to hold also for other classes of Echinodermata. The earliest stages were studied in larvæ of *Strongylocentrotus lividus;* the first deposit of calcareous matter was seen in the formative cells, where a calcareous granule of indefinite form, but with a tendency to a tetrahedron with compressed sides, could be made out; this tetraxial object is developed in the interior of the cell. As it grows one axis lags behind and a regular triaxial spicule arises, and these lie not in but by the cell, a thin homogeneous investment surrounding the spicule. With some difficulty it is possible to prove that the organic investment is retained by the spicule of the adult. This is best done by slowly dissolving the chalk by acids, and observing the process under a high power. In large spicules it is quite easy to detect the central canal, and it is almost certain that there is an organic axial substance in all calcareous bodies of Echinoderms. This axial substance does not appear to be a compact mass, but to consist of a fine plexus, the filaments of which are strongest in the centre. The calcareous bodies appear to consist of alternately arranged and concentric layers of calcareous and organic substances. The latter are much thinner than the former, and decrease in thickness from the centre to the periphery.

The author insists on the primitively tetrahedral condition of the spicules, and points out that in some—as the wheels of Auriculariæ and Holothurians—the tetraxial arrangement persists. A regular triaxial form is one in which the rays are set at an angle of 120°; and it is at this angle that, without exception, all further divisions and branches are made; the further divisions made thus regularly must result in a regular network, and it is clear that the intervening spaces between the bars must be regularly hexagonal. All the complicated calcareous structures such as we find in the firm skeletal parts of Crinoids, Asteroids, and Ophiuroids, as well as the plates and calcareous rings of Holothurians, all consist ontogenetically of a network perforated by regular hexagons.

The calcareous bodies which remain tetraxial are morphologically the most interesting; in the spines of Echinoderms the fourth axis is the

* MT. Zool. Stat. Neapel, vii. (1887) pp. 272–300 (2 pls.).

primary axis of longitudinal growth; they may be seen in *Asterina* or *Pluteus paradoxus;* they are probably a good deal modified in the turriform bodies of pedate Holothurians, but this is a point which requires further investigation. Notwithstanding the various slight differences which obtain in the hard structures the development, histology, and morphology of the calcareous bodies show a union and resemblance which help to mark off the Echinodermata from other divisions of the animal kingdom.

Cœlenterata.

Stinging-cells.*—Dr. R. v. Lendenfeld gives a useful summary of researches by himself and many others on the structure and function of stinging-cells. His account is useful both as an historical review and as a systematic summary of what is definitely established with respect to these elements. In regard to the mechanism of discharge, he sums up as follows:—(*a*) Hamann's stalk is a support without any active role in the discharge; (*b*) the granular basal process is a nerve; (*c*) the protoplasmic mantle is contractile, and by its contraction the capsule, open superiorly, is compressed and the thread protruded; (*d*) the cnidoblast admits of the discharge of the nematocyst in this way that a pressure on the apex from without is transmitted to the plasmic mantle of the cnidoblast and occasions its contraction; (*e*) this direct reflex action may, however, be inhibited by a voluntary nervous stimulus, so that even when the cnidocil is touched the animal may prevent any explosion.

Formation of fresh stalks in Tubularia.†—Dr. P. Mayer expresses the opinion that what Herr Klaatsch has lately taken for the formation of fresh stalks in *Tubularia* are artificial products, and he thinks an examination of his figures will show this to be the case; we have here an example of the danger of trusting solely to preserved material.

New Rhizostomatous Medusa.‡—Mr. J. W. Fewkes describes a Medusa of about 18 inches in diameter when alive, which was taken in New Haven harbour. As it appears to belong to the acraspedote family *Pilemidæ*, it may be called *Nectopilema* (*verrilli*); it appears to be most closely allied to *Pilema* and *Rhopilema*, though differing from them in various particulars; it appears to connect the second division of the Pilemidæ—the Eupilemidæ—with the third or Stomolophidæ, and its generic characters may be given thus:—Six velar lappets in each octant; no tentacles; sixteen scapulettes; eight oral arms with numerous gelatinous filiform appendages. These last vary in size and length; the term scapulettes is the English of Häckel's "Scapuletten" and appears to be a preferable term to the more frequently used "leaf-like appendages."

Anatomy and Histology of Veretillum.§—Dr. A. Korotneff finds that the polyps of *Veretillum* have a very complex structure, there being a differentiated nervous system and special cell-elements which cause the extraordinary phosphorescence of the animal. In the cone the ectoderm consists of epithelium, a differentiated musculature, and a nervous system closely connected with the luminous cells. The epithelial cells are much elongated and are continued into fine filaments, which pass transversely through the musculature, and there are also spindle-shaped sensitive cells which are drawn out into fine filaments. The muscular layer consists of fine filaments in which are independent cell-bodies. Between the epithelial

* Biol. Centralbl., vii. (1887) pp. 225–32.
† Zool. Anzeig., x. (1887) p. 365.
‡ Amer. Journ. Sci., xxxiii. (1887) pp. 119–25 (1 pl.).
§ Zool. Anzeig., x. (1887) pp. 387–90.

and muscular layers there are bipolar and multipolar nerve-cells, whence fine filaments extend in all directions; this diffuse nervous system may be compared with that found by the brothers Hertwig in the oral disc of the Actiniæ. The cells of the muscular layer often take part in forming the ectodermal epithelium, and this shows that the muscular layer is not yet, in this form, completely separated from the epithelium. Below the muscular layer there are other nerve-elements which are connected with the sub-epithelial nerves, and thus the nervous system forms a network which extends through the whole ectoderm and embraces the muscular layer. This nervous layer is specially connected with the phosphorescent property of the animal.

The septa, of which there are eight, consist of a supporting lamella, on one side of which there are longitudinal muscles and on the other transverse fibres; there are also large luminous cells, and spindle-shaped nerve-cells are to be found among the muscular fibres.

The structure of the wall of the polyp is much more primitive; the ectoderm is alone muscular, but the transverse fibres contain no special cells and belong completely to the epithelium; below this are spindle-shaped nerve-cells and luminous cells; the supporting lamella contains a well-developed plexus of connective-tissue cells; the endoderm has fat-spheres and some unicellular glands.

The sexless polyps have a special significance and structure; there is no true body-wall, the septa being attached to the oral disc; the œsophagus consists of filamentar cells with long and thick flagella, and between these extraordinarily small elongated nematocysts are imbedded, the whole forming a battery of nematocysts; so that the sexless polyp may be called a stinging polyp; when the stinging organs are ejected the œsophagus is evaginated.

Two of the septa of these sexless polyps are specially developed, their free inner margin bearing a ridge made up of flagellate cells; this ridge extends from the septa to the walls of the spongy tissue of which the body of the colony is composed; by their action a constant movement of water is kept up. It should be added that the oral disc of each polyp is provided with nervous elements which bring about the evagination of the œsophagus, and there are small light-cells.

The large sexual polyps are all male, the ova being developed in the rhachis, where they form four longitudinal cords, attached to the four sides of the internal axial canal. As the eggs are placed near the asexual polyps it may be supposed that all the polyps were primitively sexual; some in time became reduced, and the female elements passed into the interior of the colony.

Protozoa.

Conjugation of Ciliate Infusoria.*—M. E. Maupas has studied the conjugation of *Onychodromus grandis* and *Stylonichia pustulata*. The former, in conjugating, is always provided with two nucleoli; in several individuals the exchange of the male pronucleus was observed, and then its union and fusion with the female pronucleus. Separation takes place a little later, and by a kind of ecdysis the separated individuals renew all their appendages, the mouth and buccal membranellæ being alone wanting; the nucleus grows and soon becomes a large clear spot which occupies the centre of the body. Around the nucleus the cell becomes darkish and opaque; this is due to the presence of birefractive corpuscles of urate of soda, and of

* Comptes Rendus, cv. (1887) pp. 175–7.

numerous granules of zooamylum, which has quite the same properties as that of Gregarines. For four days the separated individuals have no mouth; they then undergo a second shedding of all their appendages, after which the mouth appears, normally constituted; at the same time the new nuclear body elongates and divides into two. Nourishment and growth are succeeded on the next day by a second division of the nuclei. The *Onychodromi* continue to eat greedily, and thirty-four to thirty-six hours after the reconstitution of their mouth they begin to divide, and for a third time to shed their appendages; the primitive nuclear bodies are completely absorbed.

In *Leucophrys patula* conjugation is effected by small mouthless individuals, such individuals having first divided fissiparously three, four, or five times according to their size. In several cases the author has observed the exchange of the male pronucleus and its fusion with the female. The representatives of this species begin to eat almost directly after separation; the primitive nucleus is completely absorbed.

As a matter of fact, M. Maupas has directly observed the exchange and fusion of the two pronuclei in six species—*Paramæcium caudatum*, *P. aurelia*, *Stylonichia pustulata*, *Onychodromus grandis*, *Spirostomum teres*, and *Leucophrys patula;* the exchange, but not the fusion, has been seen in *Euplotes patella* and *Colpidium colpoda;* so that the exchange and fusion of the pronucleus may be looked upon as being the essential act in the conjugation of the Ciliata.

New Fresh-water Infusoria.*—Mr. W. M. Maskell communicates the results of an inquiry made by himself and four coadjutors into the fresh-water Infusoria of the Wellington district. The catalogue includes among many others the following species, of which diagnoses are given:—*Cercomonas grandis* n. sp. (very large size), *Rhipidodendron huxleyi* Kent (as at Dartmoor in association with *Spongomonas sacculus*), *Trachelomonas crenulatocollis* n. sp. (fluted tubular neck, rough lorica, absence of caudal spines), *Prorodon sulcatus* n. sp. (longitudinal furrows, narrow pharynx, inconspicuous rods), *Tillina enormis* n. sp. (long oral cilia, no vibratile membrane, two contractile vacuoles), *Tillina inæqualis* n. sp. (unequal anterior and posterior portions, shallow depressions between them), *Trachelocerca filiformis* n. sp. (posterior single contractile vesicle, elliptical sublateral nucleus), *Plagiopyla varians* n. sp. (two contractile vesicles, posterior conspicuous nucleus, variable oral fossa), *Pleuronema cyclidium* n. sp. (very minute size), *Stentor gracilis* n. sp. (slender extended stem, sudden widening of peristome, deep lateral cleft, white colour), *Licnophora setifera* n. sp. (larger than European marine forms, strong setæ instead of cilia on foot region), *Opercularia parallela* n. sp. (more cylindrical and rough than *O. cylindrata* Wrzes., without striæ), *Histrio acuminatus* n. sp. (differing from *H. similis* Quennerstedt in fresh-water habitat and acuminate posterior extremity), *Acineta elegans* n. sp. (lorica vase shaped with reversed margin, widening below edge and rapidly compressed beneath, produced downwards to a point whence a short pedicel), *Acineta simplex* n. sp. (tentacles in two groups, but much smaller than *A. grandis* Kent, and with much more rapidly tapering lorica, obtusely pointed at base.

Thalassicola cærulea.†—Herr C. J. Eberth has applied the resources of modern technique to the investigation of the minute structure of *Thalassicola cærulea.* Freshly captured specimens were placed for a short time in iodized alcohol, and then in alcoholic solutions of increasing strength

* Trans. New Zealand Inst., xix. (1886) pp. 49–61 (2 pls.).
† Arch. f. Mikr. Anat., xxx. (1887) pp. 27–31 (1 pl.).

from 40–90 per cent. After sufficient hardening the organisms were imbedded, first in dilute, then in concentrated celloidin, and cut in sections with the microtome. The sections were then stained with hæmatoxylin. The structures within the central capsule, which when intact is very impenetrable, were then readily demonstrated. The beautiful blue colour, which is probably due to the oil-globules, is removed by the alcohol, and the central portions appear brownish. The extra-capsular protoplasm appears quite homogeneous, is stained blue by the hæmatoxylin, and exhibits here and there fine strands, which extend outwards from the layer which gives origin to the pseudopodia, and share with the protoplasm of this region fine brown pigment-bodies.

The region which gives origin to the pseudopodia contains not only small, but also large vacuoles, inclosing roundish angular spherules and long strands of variable breadth, sometimes homogeneous, sometimes longitudinally striated, and often with a distinct nucleus. Higher powers reveal a fine transverse striation, and the roundish angular bodies are seen to be cross sections of these muscular strands. Since Brandt has shown that foreign bodies can only remain attached to the surface, the muscular shreds found in the layer which gives origin to the pseudopodia must either be remains of the bodies of animals which have forced their way inwards, or, if no other remnants are to be found, they must be the only portions taken up by the *Thalassicola*. How these ingested muscle-fragments find their way in cannot be answered without further observation. It was noticeable that beyond a disruption of the fibrillæ no change was detectable.

The spherical central capsule is bordered by a membrane penetrated by numerous pores without special arrangement. On surface view the pores appear to be included in a finely granular mass without pigment; on cross sections this appears to be beset on both sides with small pointed hairs, which are probably minute stumps of the protoplasmic processes penetrating the pores.

The intracapsular protoplasm exhibits three zones: an external one distinctly striated radially, a broad median vacuolar zone, and a narrow internal layer with indistinct radial striation. The whole medullary mass appears finely granular, but higher powers exhibit a fine frothy structure, particularly prominent in the outer zone. There is no radial arrangement of granules, and the differentiation of keel-shaped plasmic portions is wholly due to the thicker strands of protoplasm. Very delicate bridges connect the keel-shaped portions. This structure is obscured in the median zone by the recurrence of simple or composite vacuoles. These inclose hyaline spherules containing concentrically arranged spherical concretions, probably composed of carbonate of lime.

The nucleus is roundish, and bordered by a double-contoured membrane. It appears to be almost homogeneous, but higher powers demonstrate the presence of a narrow-meshed framework. The proper chromatin substance is limited to 15–20 roundish angular nucleoli, round which the nuclear network is usually looser, so that they appear to be surrounded by clear spaces. They are, however, connected by fine threads to the framework. They stain very unequally.

Artificial Development in Actinosphærium.*—Prof. A. Gruber calls attention to a neglected observation by K. Brandt, which appeared in an inaugural dissertation—one of the best places for hiding observations—in 1877. "This division may be brought about artificially by cutting up the

* Zool. Anzeig., x. pp. 346–7.

animal into any number of pieces. Each of these, as Eichhorn has already observed, becomes a complete animal in a few hours. Greef has carried artificial multiplication very much further. He divided a single example into twenty to thirty fragments which soon sent out rounded pseudopodia, became differentiated into ecto- and endosarc, and finally completely resembled young individuals which had been produced naturally. But this change was effected in those fragments only which contained at least one nucleus; those without nuclei, or isolated nuclei died down. A uninuclear individual represents a simple naked cell which contains all the essential constituents of the Actinosphærium-body, and is capable of further development and of growth into a multicellular organism." Prof. Gruber points out that this observation confirms the experiments of Nussbaum and himself, and he takes the opportunity of remarking that in what appears to be an *Actinophrys*, he has lately observed apparently complete and active individuals which had no nucleus. A more or less long existence without a nucleus is therefore possible, but he believes that new formations never arise unless one is present.

Researches on Lower Organisms.* — M. P. A. Dangeard gives an account of a new species of *Heterophrys*, *H. dispersa*, which appears to be intermediate between the Nuclearia and the Heliozoa chlamydophora. It has often a green colour from feeding on substances which contain chlorophyll. Division, which has never before been seen in this genus, is very simple, ruptures being gradually effected along a broken line; encystation has also been observed. This new form differs from *H. varians* only by having a single nucleus.

The author has made a study of *Actinophrys Sol* and thinks that it shows distinctly the affinities of the Heliozoa with *Vampyrella*, *Nuclearia*, and *Heterophrys*.

After treating of *Pseudospora*, the author forms a new genus *Barbetia* for *Pseudospora volvocis* Cnk.; its systematic position is near *Heteromita*. Among the *Vampyrellæ* we find the description of a new species, *V. Euglenæ;* it varies from 5 or 6 μ to 25 or 30 μ in length, its form is irregular, but most often spherical, and as a rule only one specimen is found on a *Euglena*.

The author justifies the inclusion of all the forms just mentioned in the animal kingdom, judging that the presence of cellulose in *Vampyrella* and *Pseudospora* cannot outbalance the evidence afforded by the mode of nutrition, of locomotion, of reproduction, and of encystation.

Structure of Gregarines.†—Herr Z. v. Roboz describes the structure and history of a new Gregarine of an orange colour which he found at Villefranche in *Salpa bicaudata*, and names *Gregarina flava*. In conjugation the united mass measured over 2·5 mm. The solitary young forms, the conjugated pair, and the spore-forming cysts are described. The three divisions of the body (epimerite, protomerite, and deutomerite) are regarded as distinctly separate chambers. The movements are described and referred to a cortical muscular layer, consisting of longitudinal and transverse fibres which the author was able to isolate. The cuticle is penetrated by fine pores. The partitions between the different parts are formed by a continuation inwards of the cuticle, and not from Schneider's sarcocyte. The sarcocyte and entocyte were readily distinguishable, the latter containing the yellow oil-globules which gave the animal its colour.

* Ann. Sci. Nat.—Bot., iv. (1886) pp. 241–75 (2 pls.).
† Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 146–7.

Karyokinetic changes in the nucleus were observed. The division of the nucleolus, the formation of nuclear asters, the complete fusion of the conjugating individual, the expulsion of polar elements, and the formation of a new nucleus, which undergoes the subsequent division, are described in the original Hungarian paper.

Spore-formation in Gregarines.*—M. L. F. Henneguy reports the results of his application of modern technical methods to the elucidation of spore-formation in *Monocystis agilis* of the earthworm. It has been observed by Lieberkühn, for instance, that the spores may arise in different ways. Sometimes the cyst becomes covered with small clear vesicles which develope into pseudo-navicellæ; sometimes the contents segment like an ovum; sometimes the mass divides into a number of smaller masses, each of which becomes covered with spores. It is also known that the spores inclose a nucleus, and divide into several falciform nucleated elements surrounding a central residual core—the noyau de reliquat. A. Schneider has further described the repeated division of the nucleus and the distribution of the results throughout the protoplasm.

M. Henneguy's results corroborate those of Schneider, of which the author was unaware when he began his researches. By means of sections, &c., the following points have been demonstrated. (1) First of all, vacuoles appear in the large nucleolus; this breaks up into fragments; and a true karyokinetic division of the nucleus occurs. (2) If the contents of the cyst do not also divide, and the nuclei continue to multiply by division, they migrate to the surface, and there become surrounded by a little protoplasm. They do not all move outwards, however, to form a surface layer. A certain number remain at the centre, and there degenerate. (3) When the contents of the cyst divide into a few large masses, the same formation of spores is exhibited. The nuclei of each mass multiply by karyokinesis, and move to the surface.

M. Henneguy never observed the third mode of spore-formation described by Lieberkühn, where the whole cyst segments into spores. A central core is always to be seen at a given stage. The above facts apply to the macrospores, but within the microspore cysts the same processes were observed. The latter divide into a larger number of masses than the macrospore cysts. The author noted the presence of at least two distinct species—*Monocystis agilis* and *M. magna.* In some cases *M. agilis* was alone present, and with it were associated only microspore cysts.

Both macro- and microspores inclose a large nucleus with a chromatic network. The nucleus divides by karyokinesis, and as in the case of the cysts the equatorial plate and the "pectiniform" figure were observed. Each daughter nucleus retires to an opposite pole and there undergoes two successive divisions. The results move to the centre and become surrounded by protoplasm, forming eight units round the residual core of Schneider. The general occurrence of indirect division is thus once more demonstrated.

Revision of the Microsporidia.†—M. R. Moniez has some notes preparatory to revision of the Microsporidia. He describes a species, *Nosema helminthorum*, which lives in unarmed *Tæniæ;* the same or a closely allied form has been seen in *Ascaris mystax. Nosema anomala* is probably wrongly placed among the Microsporidia, as its spores are very small, have no suture, or geminate vesicles. The species found by Vlacovich in *Coluber carbonarius* is called *Nosema heteroica.* In *Cyclops* two species—*N. parva*

* CR. Soc. Biol., 1887, 4 pp. † Comptes Rendus, civ. (1887) pp. 1312–4

and *N. virgula*—are found. From the group of the Microsporidia it appears to be necessary to remove *Amœbidium* and *Botellus; Lecaniascus polymorphus*, which is an Ascomycete; the parasite found by M. Balbiani in *Tortrix viridiana;* and, lastly, the organisms found by Leydig in the bee, which have been wrongly compared to *Closterium lunula.*

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.*

(1) Cell-structure and Protoplasm.

Structure of the Nucleus.†—According to Herr E. Zacharias, the cell-nucleus of both plants and animals is composed of two distinct substances, plastin and nuclein. After treatment with artificial gastric juice, there remain in the cells, in addition to other substances, two others undissolved, readily distinguished from one another by their micro-chemical properties.

One of these, nuclein, occurs exclusively in those elements of the nucleus which form, during division, the colourable filament-loops. In consequence of the nuclein which they contain, these portions retain, on treatment with gastric juice or hydrochloric acid, a sharply defined, peculiarly shining appearance. During the action of the gastric juice, numerous drops of an oily appearance are excreted from the cell-protoplasm, which render the form less clear. If these drops are removed by washing with alcohol or ether, and examined in dilute hydrochloric acid, it is seen that the bodies of the peculiar shining appearance described exist only in the nucleus. The other substance, plastin, is an essential constituent of the entire protoplasmic cell-contents, including the nucleus and chromatophores. Gastric juice or dilute acids do not cause in it the characteristic appearance of nuclein. Bodies which contain plastin but no nuclein appear pale and swollen after treatment with these reagents, so that the difference between the two is usually seen after remaining in them for a time. Plastin also differs from nuclein in its behaviour towards other swelling or dissolving reagents; it does not swell in preparations treated with gastric juice on addition of a 10 per cent. solution of sodium chloride, and does not disappear, like nuclein, on treatment with a mixture of 4 parts (in vol.) of the concentrated hydrochloric acid of commerce and 3 parts of water. Plastin is, however, dissolved, after some time, by pure concentrated hydrochloric acid. It dissolves less easily in alkalies than nuclein, and by this means the latter can be removed, while the former remains behind unchanged.

Nuclein possesses the property of absorbing eagerly certain pigments, especially methyl-green, which was demonstrated by the author in sections of the root of *Phajus* and of *Tradescantia.* Zacharias's nuclein corresponds to the "soluble nuclein" of Miescher, his plastin to the plastin of Reinke and the "difficultly soluble nuclein" of Miescher.

The author confirms the observations of Schmitz, Strasburger, and Zalewski, of the existence of a cell-nucleus in the Saccharomycetes; but

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Bot. Ztg., xlv. (1887) pp. 282–8, 297–304, 313–9, 329–37, 345–56, 361–72, 377–88 (1 pl.).

disputes the assertion of Schmitz, Strasburger, and Tangl that the nucleus is wanting in the Phycochromaceæ. The presence of a nucleus was demonstrated in the cells of *Tolypothrix ægagropila* and *Oscillaria* sp. (in the former it can be seen even in the living plant), while the cell-protoplasm was found to be destitute of any substances exhibiting the reactions of nuclein.

The nucleins obtained from the yolk-spheres of animal ova differ in their reaction from those of the nuclei of vegetable cells. They were obtained from the frog, from *Scyllium canicula*, and from the hen. These agree in their properties with the nuclein obtained from milk, and differ from those now under consideration in not containing the elements of nitrogenous bases, such as guanine, hypoxanthine, &c. In the vegetable kingdom structures comparable to the yolk-spheres of animals have hitherto been found only in the ovum-cells of Gymnosperms; the author has found them in *Pinus sylvestris*.

In the resting condition the cell-nucleus consists of a matrix in which the framework of the nucleus and the nucleoli are imbedded; the former is distinguished by containing nuclein; the latter consist of albumen and plastin. If the albumen is removed from the nucleus by digestion, and the nuclein dissolved in soda, a network remains behind consisting of plastin. On the chemical nature of the matrix the author was unable to come to any definite conclusions.

As to the processes which take place during the division of the nucleus, the author combats the statement of Strasburger of the intrusion of the cell-protoplasm into the substance of the nucleus. Pollen mother-cells of *Hemerocallis fulva* in the first stages of division before the disappearance of the nucleolus, preserved in alcohol, showed after treatment with hydrochloric acid very clearly the matrix of the nucleus; and this matrix does not consist of cell-protoplasm, since it does not leave behind any residue of plastin when treated with gastric juice. The same is the case also with the spindle-fibres, which are stated by Strasburger to consist of cyto-hyaloplasm.

The author then discusses the changes which take place in the material constitution of the nucleus and nucleoli during division.

The nuclei of male sexual cells—those of the spermatozoa of animals and of cryptogams, and the generative nuclei of the pollen of Gymnosperms and Angiosperms—all exhibit essentially similar properties; they contain a larger quantity of nuclein than the nuclei of vegetative cells, and either smaller nucleoli or none at all.

The nuclei of the male and female sexual cells differ materially in their properties in the case of ferns (*Pteris serrulata*). The nucleus of the male cell contains no nucleoli, and apparently consists of a homogeneous mass composed essentially of nuclein. The nucleus of the female cell, on the other hand, encloses large nucleoli and no nuclein, but a network or framework exhibiting the reactions of plastin. The same is the case in Muscineæ, and, to a less extent, in Gymnosperms. In the latter a similarity is exhibited on the one hand between the nuclei of the canal-cells and the spermatozoids, and, on the other hand, between those of the ovum-cell and the vegetative nucleus of the pollen-tube. In Angiosperms the difference between the nuclei of the male and female cells is less striking than in the lower plants. In animals the same difference is presented between the nucleus of the ovum and that of the spermatozoid before impregnation as in the case of ferns and Muscineæ. In both animals and plants the nucleus of the male cell undergoes changes after its absorption into the female cell, resulting in a close approximation to the nucleus of the latter.

Functions of the Nucleus.*—In reference to the prevalent theory that all the vital properties of the cell are derived from the nucleus, Herr G. Klebs has made a number of observations on living cells of *Zygnema* plasmolysed by the action of a 16 per cent. solution of sugar. One effect of the plasmolysis is to cause the contracted cell-contents to divide mechanically into two halves, each including one of the two chlorophyll-bodies, while the whole of the nucleus is contained in one of the two halves. If the cultivation of such a plasmolysed *Zygnema*-filament is continued, it is seen that the two halves of each cell exhibit very different phenomena. The protoplasmic mass which contains the nucleus surrounds itself with a new cell-wall, and the single chlorophyll-body divides into two, between which is the nucleus. The half-cell soon begins to grow, and becomes a complete normal cell. The half-cells destitute of nuclei retain their vitality in some cases for as long a period as six weeks, during which time respiration and metastasis must necessarily go on, and starch is produced even more abundantly than in the portions which contain nuclei. They have, however, no power of developing a new cell-wall, and the same was the case in other examples observed, as *Spirogyra* and *Œdogonium*. That this power is dependent on the presence of a nucleus was shown by instances in which the two halves were not completely separated, but remained connected by a narrow isthmus, when both halves became enclosed in new cell-walls. The power of increasing in length goes also along with that of developing a new cell-wall. Similar results were obtained with *Funaria hygrometrica*.

The author concludes that the power of a cell to develope a cell-wall, and that of increasing in length, are essentially connected with the presence of a nucleus, while the properties of assimilation and respiration are derived from some other constituent of the cell.

(2) Other Cell-contents.

Proteids of the Seeds of Abrus precatorius.†—Mr. S. Martin states that the proteids of the seeds of *Abrus*, the Indian liquorice, are important physiologically, because they have been shown to be possessed of poisonous properties. The method of extraction used was based on the supposition that the proteids present in *Abrus* were similar to those in other seeds, consisting chiefly of the globulin and albumose classes. The finely ground seeds were shaken first of all with chloroform to remove the red cuticle which sinks in this liquid, so that the yellow kernel-powder could be easily removed, and obtained in the dry state by allowing the chloroform to evaporate. The powder obtained was then extracted with 15 per cent. sodium chloride solution for twenty-four hours, and the mixture filtered. The yellowish filtrate was distinctly acid, and gave a copious precipitate on boiling. The proteids were separated from this filtrate in two ways.

(1) Saturation with neutral ammonium sulphate and shaking for four hours throws down all the proteids in solution. (2) Saturation with sodium chloride and shaking for many hours gives only a scanty precipitate, which becomes copious on adding a large excess of glacial acetic acid. The properties of the globulin are that it is insoluble in distilled water, but readily soluble in 10 to 15 per cent. sodium chloride or magnesium sulphate solution. It is completely precipitated from solution by saturation with sodium chloride after slightly acidifying. The albumose is soluble in cold or boiling distilled water. It is not precipitated from

* Biol. Centralbl., vii. (1887) pp. 161–8, and Ber. Deutsch. Bot. Gesell., v. (1887) pp. 181–8.

† Proc. Roy. Soc. Lond., xlii. (1887) pp. 331–4.

solution by saturation with sodium chloride, unless a large excess of glacial acetic or phosphoric acid be added.

The author concludes by saying that there are, therefore, two proteids in the seeds of *Abrus precatorius*, a vegetable paraglobulin and an α-phytalbumose.

Cholin in Seedlings.*—Herr E. Schulze records the presence of this nitrogenous base in seedlings of lupin and gourd; this was determined by analysis of the double salt of gold and platinum.

Crystalloids in Stylidium and Æschynanthus.†—Herr C. Raunkiaer finds crystalloids in the epidermal cells of the under-side of the corolla-lobes of *Stylidium adustum*, and in the epidermal cells, especially of the leaves, of several species of *Æschynanthus*. They occur in the form of rhombic discs, 1–4 in each nucleus. They dissolve very rapidly on addition of water or alcohol, but, as the author thinks, not from solubility in the reagent, but from the access of the acid cell-sap.

Occurrence and Function of Tannin in Tissues.‡—Dr. M. Westermaier has investigated the conditions of the formation of tannin in a number of both herbaceous and woody plants (*Impatiens parviflora, Poterium Sanguisorba, Alchemilla vulgaris, Mespilus germanica, Quercus pedunculata*, &c.). He considers its formation to be distinctly dependent on illumination; in etiolated leaves and leaf-stalks it may even be altogether wanting. The tannin increases in the assimilating cells in the light; its increase and decrease appear to depend to a large extent on the same conditions as the increase and decrease of chlorophyll.

True Nature of Starch Cellulose.§—Herr Griessmayer has undertaken an investigation to ascertain the true nature of the coating said to surround the true grains of starch (granulose). Meyer considers this coating not to consist of a compound present in the unaltered granule, but to be the result of change of the starch. The coatings can be obtained by the following method: 1000 grains of potato starch are allowed to remain for 100 days in 6 litres of 12 per cent. hydrochloric acid; the coatings are then separated and filtered off, and washed with water; when dried they weigh about 300 grains, and when boiled in water they dissolve almost entirely; there remains, however, a small portion of cellulose tissue, fat, &c.; from the solution, cold causes the dissolved compound to separate, forming sphero-crystals of amylodextrin.

(4) Structure of Tissues.

Differentiation of Epidermal Cells.‖—Herr E. Heinricher observes that in some plants belonging to the Cruciferæ some of the epidermal cells are from 10 to 20 or even 100 times larger than the adjacent cells. These large cells may be either solitary or associated in groups. This occurs in the stem as well as the leaves; in *Halophila pilosa* they attain a length of 8 mm. The object of these large cells appears to be to serve as a storage of water; they are found especially in species growing in very dry situations; where they are present, even cut shoots remain a long time without withering.

* Zeitschr. f. Physiol. Chem., xi. p. 365. See Naturforscher, xx. (1887) p. 261.
† Bot. Tidsskr., xvi. (1887) pp. 41–5. See Bot. Centralbl., xxx. (1887) p. 236.
‡ SB. K. Preuss. Akad. Wiss. Berlin, ix. (1887) pp. 127–44 (1 pl.).
§ Bied. Centr., 1887, pp. 190–2. See Journ. Chem. Soc. Lond., 1887—Abstr., p. 686. Cf. this Journal, *ante*, p. 256.
‖ MT. Naturw. Ver. Steiermark, 1886, 29 pp. and 1 pl. See Bot. Centralbl., xxx. (1887) p. 305.

Network of Cells surrounding the Endoderm in the Roots of Cruciferæ.*—M. P. van Tieghem states that he has already shown that a great number of the Coniferæ, more particularly Cupressineæ and Taxineæ, have the cells of the cortical portion of the young root in contact with the endoderm strengthened by ligneous thickenings. An anatomical and physiological arrangement similar to this has been described by Woronin as occurring in the cabbage, and the author has recently studied a number of Cruciferæ; the results of his investigations are detailed.

A series of transverse and longitudinal sections were made of the root of *Sinapis alba*, before the formation of secondary tissue; these were stained with fuchsin. All the cells of the last cortical layer but one were exactly superposed to those of the endoderm, and the cells of the ante-penultimate layer were provided towards the middle of their radial and transverse faces with a strong thickening band, which was stained red by the reagent. From each band a series of lesser bands spread towards the interior. The author states that a network of cells surrounding the endoderm occurs in *Cheiranthus*, *Alyssum*, *Koniga*, *Farsetia*, *Berteroa*, *Vesicaria*, *Cochlearia*, *Malcolmia*, *Sisymbrium*, *Brassica*, &c.; while in *Matthiola*, *Nasturtium*, *Barbarea*, *Arabis*, *Turritis*, *Hesperis*, *Erysimum*, *Camelina*, *Diplotaxis*, *Iberis*, &c., this arrangement has not been found to occur.

Cortical Fibrovascular Bundles in Lecythideæ and Barringtonieæ.†—In some genera belonging to these orders Prof. M. M. Hartog finds a complete system of cortical bundles external to the pericycle, anastomosing with the leaf-traces at the nodes. They have often a complete circle of exogenous wood without pith, and a crescent of phloem on the outer side; they are all but concentric.

Passage of Fibrovascular Bundles from the Branch to the Leaf.‡—Dr. C. Acqua, agreeing generally with the observations of Petit, § distinguishes 13 types of arrangement and distribution in the passage of the fibrovascular bundles from the branch to the leaf, dependent on the number of distinct cords of bundles which enter the leaf, the degree to which these cords unite or anastomose, and other points. Without attaching too much importance to the structure of the leaf-stalk, this may yet, in many cases, be usefully observed for systematic purposes. In all cases observed, where the bundles enter the leaf in a single cord or arc, the leaf itself was simple.

Second Primary Wood of the Root.‖—M. P. van Tieghem states that it is well known that the primary wood of the root consists of a certain number of radiating woody bundles developed centripetally, alternating with a like number of liber-bundles, so that secondary wood, when it is produced, consists of vascular tangential bundles developed centrifugally, superposed internally to the liber-bundles. It is admitted that all the primary wood of the root is contained in the centripetally developed bundles, but it does not follow, as is usually supposed, that all the secondary wood is contained in the centrifugally developed bundles. It certainly is so in a great number of plants; but in many others the arrangement is different. The object of this paper is to explain the structure of the latter.

The author designates the centripetally formed vascular bundles alternating with the liber-bundles, as *protoxylem*, and the centrifugally formed

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 125–30.
† Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 706.
‡ Malpighia, i. (1887) pp. 277–82. § See this Journal, *ante*, p. 264.
‖ Bull. Soc. Bot. France, xxxiv. (1887) pp. 101–5.

vascular bundles superposed to the liber-bundles, as *metaxylem*. In the same manner a *metaphloem*, as contrasted with the *protophloem*, is formed contemporaneously with the metaxylem. He sums up his conclusions as follows:—In the primary structure of the root two types may be distinguished: (1) the monoxylic type, where the wood remains in the condition of protoxylem; and (2) the diploxylic type, where the protoxylem is followed by metaxylem. Where there is any secondary wood, its first vessels are placed opposite the last vessels of the metaxylem, which it continues in a centrifugal direction.

Formation of the Annual Ring and Growth in Thickness.*—For the purpose of throwing light on the difference in structure between the spring and the autumn wood in the annual ring of dicotyledonous woody plants, Herr A. Wieler has investigated the corresponding phenomenon in a large number of annual plants, and in the annual stems of perennial plants. He finds that in many of these a true annual ring is formed, and very probably in all when the climatic conditions are favourable. This is evidently the case in *Helianthus annuus* and *Ricinus communis;* and here he believes he was able to demonstrate that the formation of the ring is dependent entirely on differences in the supply of nutriment at different periods of the year.

Autumnal Fall of Leaves.†—Prof. W. Hillhouse proposes to call the layer of cells formed by renewed cell-division in the basal plane of the leaf-stalk, the formation of which causes the dissociation of the leaf, the *absciss-layer*. It is readily recognized by the new dividing-walls formed across the cellular tissue of the base of the leaf-stalk, and by the large quantity of protoplasm contained in the cells, usually accompanied by numerous small starch-grains. It is usually formed very shortly before the fall of the leaf, which is due to the increased turgidity of the cells of the absciss-layer, owing to their osmotic activity; they become strongly rounded, their adhesion diminishing at the same time. The soft elements of the vascular bundles are either pinched, or else cell-division takes place in them also; the lignified elements also undergo changes.

In leaves about to fall starch is always found in the sieve-tubes, mainly collected in cloudy granular-looking masses in the neighbourhood of the sieve-plates; this starch stains brown or reddish-brown with iodine. The nucleus, or at least the chromatin, appears to be left behind in the empty cells of fallen leaves, the nucleus tending towards disintegration, as distinguished from fragmentation or direct division. In the leaves of evergreens examined, starch was also absent in winter, being transferred to the stem, while the tannin, on the other hand, remained behind, as is also the case in fallen leaves.

(5) Structure of Organs.

Seedlings of Salicornia herbacea.‡—Herr A. Winkler describes the structure of the seedlings of this plant, which possess the peculiarity of the two cotyledons being coalescent at their base, the cone of growth lying in a depression between them.

Formation of Rootlets and position of Buds in the Binary Roots of Phanerogams.§—M. P. van Tieghem states that the place of formation of rootlets in the pericycle of the mother-root is fixed by two rules, and not

* Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 70–132 (2 pls.).
† Rep. Brit. Assoc. Birmingham Meeting, 1886, pp. 700–1.
‡ Verhandl. Bot. Ver. Prov. Brandenburg, xxviii. (1887) pp. 32–3.
§ Bull. Soc. Bot. France, xxxiv. (1887) pp. 11–6 and 39–44.

by one only, as has been the theory up to the present time. Firstly, when the mother-root possesses more than two woody bundles, and secondly, when the mother-root only possesses two woody bundles. Whenever the structure is binary, the root, whether it be terminal or lateral, or whether it belong to the primary or secondary or any other order, forms its rootlets in the pericycle opposite the intervals which separate the two woody bundles from the two liber-bundles.

It is a well-known fact that certain Phanerogams produce regularly buds upon their roots and upon the hypocotyledonary portion of their stems. These are normal buds, and must not be confused with adventitious buds. Firstly, with regard to the buds which appear shortly after germination on the lower portion of the hypocotyledonary stem. In order to form one of these buds, three epidermal cells situated at the extremity of the ray which passes between the two liber-bundles and the two woody bundles, divide first by radial, then by tangential and oblique septa, and produce a mass of small cells which forms a projection on the external surface. The bud then is entirely of epidermal origin. The radical buds, on the other hand, are produced at the base of the primary rootlets, and are enclosed within the cortex of the terminal root; their actual production takes place in the same manner as has been described in the case of hypocotyledonary buds.

Both radical and hypocotyledonary buds are, therefore, distributed in the root in the same manner as rootlets, and in the stem in the same manner as lateral roots. Frequently they are formed at the same depth as rootlets and lateral roots, that is to say, in the pericycle, and are to the same extent endogenous; but sometimes, as in *Linaria*, they are formed in the epidermis, and are exogenous.

Origin of Rootlets and Lateral Roots in Rubiaceæ, Violaceæ, and Apocynaceæ.*—MM. P. van Tieghem and H. Douliot state that in Rubiaceæ the terminal root is binary, and consequently produces its rootlets opposite the intervals which separate the two woody bundles from the two liber-bundles. In Violaceæ the terminal binary root (*Viola nana*, *V. odorata*), or a lateral binary root (*V. canadensis*), produces its rootlets in four series in its pericycle. In Apocynaceæ the rootlets are formed opposite the woody bundles. In the violet (*V. nana*) and in Rubiaceæ the lateral roots which are produced after germination in the hypocotyledonary stem proceed from the pericycle; in fact, their origin is the same as that of the rootlets.

The authors then describe in detail the formation of the lateral roots in *Asperula taurina*. They conclude the paper by stating that, seeing that the formation of rootlets and early lateral roots in Leguminosæ, Cucurbitaceæ, Rubiaceæ, Violaceæ, and Apocynaceæ is found to take place in the usual manner, one can see that only one type of formation for these exists among Dicotyledons.

In a previous paper † the authors have shown the same to be the case among Monocotyledons; and it is well known that in Gymnosperms the rootlets are formed in the pericycle of the mother-root. In Vascular Cryptogams it is the endoderm of the root which gives rise to rootlets and lateral roots; but in this case the endoderm is the external layer of the pericycle. The general conclusion of the authors is that in all vascular plants the rootlets and the early lateral roots are formed in the pericycle of the generating member.

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 150–4.

† See this Journal, *ante*, p. 262.

Formation of Tubers.*—Herr H. Vöchting has investigated the cause of the formation of underground tubers, which he believes to be primarily the absence of light, and secondarily an abundant supply of water. Tubers are, however, frequently formed above ground, and even sometimes on parts which are fully illuminated. Their production is then due to internal causes perpetuated by heredity. Tubers may be either annual as in the potato and artichoke, or perennial as in species of *Begonia.*

Positively geotropic Shoots of Cordyline australis.†—Prof. F. O. Bower found that when stems of this plant assumed an oblique or horizontal position by reason of the weight of the head of leaves, axillary shoots were formed on the lower side pointing directly downwards; the apex of these shoots remaining covered with scale-leaves. We have here a special adaptation for the mechanical and physiological support of a weakly axis.

Structure and Development of the Suckers of Melampyrum pratense.‡—M. Leclerc du Sablon states that the primary cause of the formation of the suckers of *Melampyrum pratense* seems to be contact with a body containing nutritive matter of use to the plant. A small protuberance is formed proceeding from the cortex; the cells composing the two layers of the cortical parenchyma elongate radially, and are then divided by septa in different directions. The cells of the endoderm then elongate radially and divide in the same manner, and finally the cells of the pericycle are divided by tangential septa. The sucker is composed of a mass of homogeneous parenchyma, the cells of which are filled with protoplasm which is more or less dense.

Ascidia of Cephalotus follicularis.§—M. P. Maury states that the leaves of *Cephalotus follicularis* are of two kinds; some have an entire limb, and are oval; the others are ascidia, and have a cylindrical petiole. A transverse section of the petiole made about a centimetre from the point of attachment of the ascidia shows seven fibrovascular bundles disposed in a circle. Near the point of attachment the circle of bundles is divided into two arcs: one above, composed of three bundles; the other lower, composed of four. The cells in the epidermis of the ascidia are more or less sinuous. Stomata are present; the guard-cells on the side of the opening are provided with cellulose thickenings.

The author divides the interior of the ascidia into five divisions:—(1) The interior face of the operculum, (2) the neck, (3) the middle portion, (4) the lateral coloured patches, and (5) the lower portion.

Histology of Vine-leaves.‖—In reference to the current statement that the spores of *Peronospora viticola* put out filaments which find their way into the tissue of vine-leaves through the stomata, Sig. P. Pichi has examined the leaves of several species of *Vitis* and *Cissus*, and finds uniformly an entire absence of stomata from the upper surface, while they are present in large numbers on the under surface and in smaller numbers on the leaf-stalk. The cells of the upper epidermis of the leaf differ from those of the under epidermis chiefly in the folding of their walls.

Structure and Development of Palm-leaves.¶—Herr A. Naumann has undertaken an examination of the history of development of the pinnate or otherwise compound leaves in a number of species of palm:—*Phœnix dacty-*

* Vöchting, H., Ueb. d. Bildung der Knollen, 55 pp., 5 pls., and 5 figs., Cassel, 1887. See Bot. Centralbl., xxx. (1887) p. 339.

† Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 699.

‡ Bull. Soc. Bot. France, xxxiv. (1887) pp. 154–8.

§ Ibid., pp. 164–8.

‖ Atti Soc. Tosc. Sci. Nat., 1887, Proc. Verb., pp. 197–8.

¶ Flora, lxx. (1887) pp. 193–202, 209–18, 227–42, 250–7 (2 pls.).

lifera and several other species, *Dæmonerops melanochæte*, *Hyophorbe indica*, *Seaforthia elegans*, *Bactris setosa*, *Chamædorea elegans* and two other species, *Chamærops humilis*, *Livistona australis*, *Rhapis flabelliformis*, and in *Carludovica palmata* (Pandanaceæ).

The leaf of all palms originates on the cone of growth as a circular wall of unequal height, not completely embracing the cone at its lower part, but which becomes closed by subsequent growth, and forms at this region the origin of the sheath. At the higher portion of the cushion, which subsequently becomes the rachis, a lamina is formed at an early period, which has the form of a cap, and which has the same origin in ferns with both pinnate and digitate leaves. The rudiment of the lamina is visible in a flat cushion which runs obliquely down the rudiment of the rachis. In the species with pinnate leaves the rudiments of the pinnæ are unsymmetrical on the two sides of the rachis. At a very early period in all families of palms, furrows make their appearance on both the upper and under side of the leaves, vertical in the digitate, horizontal in the pinnate species, which develope into fissures. In an early stage the lamina of all palm-leaves is therefore perfectly continuous; the alternation of these furrows with cushions gives an appearance which has been erroneously ascribed by previous writers to a folding of the lamina.

The variations in different species are described in detail with regard to the vernation, the mode of separation of the segments of the lamina, and the unfolding of the leaf. The so-called "ligula" occurs in all palms with digitate leaves, but varies greatly in size. It is not present in the digitate leaves of *Carludovica*.

Stipular Sheath of Polygonum.*—Herr A. Y. Grevillius describes the structure of the stipular sheath or ochrea in several species of *Polygonum*, some of terrestrial, some of aquatic habit, and suggests that its very unequal development in the different species is connected with their different biological conditions.

Turgidity of Petals.†—Prof. O. Beccari has noticed the existence of water in a state of strong tension in the cells of the thick petals of *Magnolia Yulan*, *Nerium Oleander*, and *Camellia japonica*, and in the leaves of *Rumex Lunaria*, shown by the appearance of a little cloud of vapour when the epidermis is removed.

Spike-like partial inflorescence of the Rhyncosporeæ.‡—According to Herr L. Celakovsky, the Rhyncosporeæ and Gahnieæ differ from the other sections of the Cyperaceæ in the divisions of the inflorescence not being true spikes, but spike-like cymes consisting in most instances of only two or three flowers.

Zygomorphy of Flowers.§—Prof. F. Delpino describes the various degrees of zygomorphy which occur in different flowers, and classifies the forms of flowers as follows in relation to their mode of pollination.

Omnilateral actinomorphic are among the least specialized flowers, and are adapted to the visits of insects of various kinds; such are those of *Ranunculus*, *Rosa*, *Potentilla*, *Pæonia*, *Nymphæa*, &c. *Sexlateral actinomorphic* flowers, such as those of many species of *Lilium*, are specially adapted to the visits of Sphyngidæ, while those which are *quinquelateral and actinomorphic*, such as *Aquilegia* and the Apocynaceæ and Asclepiadeæ,

* Naturf. Studentsällsk. Upsala, Dec. 7, 1886. See Bot. Centralbl., xxx. (1887) pp. 254–5, 287–8, 333–5. Cf. this Journal, *ante*, p. 430.

† Malpighia, i. (1887) p. 420.

‡ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 148–52 (1 fig.).

§ Malpighia, i. (1887) pp. 245–62. Cf. this Journal, *ante*, p. 266.

are contrived for Apidæ and Lepidoptera with a longer or shorter proboscis. Of *trilateral actinomorphic* flowers an example occurs in *Iris*, with adaptation to the visits of the larger Apidæ, such as *Bombus*, &c., and the same is the case with the *bilateral* flowers of *Dicentra*, probably similar to the primitive type of the nearly allied Cruciferæ.

Monocentric actinomorphic or *subzygomorphic* flowers are those with a longer or shorter tube, visibly adapted to insects furnished with a proboscis. *Lychnis dioica* and some species of *Clerodendron* may be cited as examples.

The very numerous *unilateral zygomorphic* flowers may be again classified, either according to the region of the visiting insect which becomes pollinated, as *nototribal*, *sternotribal*, and *pleurotribal*, or according to the class to which the visiting insect (or bird) belongs, as *melittophilous*, *sphyngophilous*, or *ornithophilous*. Nototribal melittophilous flowers include the Labiatæ, Scrophulariaceæ, Bignoniaceæ, &c.; nototribal ornithophilous flowers are exclusively exotic. Among the sternotribal melittophilous are included the greater part of Papilionaceæ, *Viola*, *Rhododendron*, &c.; *Amaryllis formosissima* is sternotribal and ornithophilous; *Lilium longiflorum* and *Funckia* sternotribal and sphyngophilous. Zygomorphic pleurotribal flowers are almost entirely melittophilous, such as Polygaleæ, some Papilionaceæ, &c.

In those families in which zygomorphy is most strongly pronounced, there is scarcely a single instance of anemophilous flowers.

Origin of Zygomorphic Flowers.*—Herr W. O. Focke suggests a probable origin of zygomorphic flowers from a comparison with those whorls of leaves, such as those of *Catalpa syringæfolia*, where one leaf in the whorl is more fully developed than the others, viz. the one which is most exposed to air and light. He calls attention to two specially marked types of zygomorphy, viz.:—(1) The Leguminosæ-type, which appears to have originated in a curvature of the style causing the concave side to be directed upwards, and which may be the simple result of light-irritation; the petals are here quite distinct or only slightly coherent at the base; to this type belong, besides the Leguminosæ, some Amaryllideæ, Chrysobalaneæ, and Geraniaceæ. (2) The Labiatæ-type, where the corolla is distinctly gamopetalous, often two-lipped, and the stamens have a tendency to become didynamous; to this type belong the Lobeliaceæ, Caprifoliaceæ, Bignoniaceæ, Scrophulariaceæ, and Labiatæ, with a modified form in the Compositæ. Besides these are several other less clearly marked types, the origin of which is not so clear.

Conduction of Irritation in irritable stigmas.† — Mr. F. W. Oliver has investigated the mode of conduction of the irritation in the stigmas of *Martynia lutea* and *proboscidea* and *Mimulus luteus* and *cardinalis*, and believes it to be due to the continuity of the protoplasm from cell to cell, which he was able to demonstrate by Gardiner's method of sulphuric acid and Hoffmann's blue.

In both the genera mentioned, the tissue of the stigma consists of two lamellæ which are sensitive to contact on the inner side only. The internal tissue of the lamellæ is composed of 15 to 20 layers of excessively thin-walled prismatic cells with a great development of intercellular spaces. Between the upper and lower epidermis of the lamellæ runs a simple axile vascular bundle of spirally thickened tracheids. The bundles from the two stigmas do not unite before they reach the ovary. The irritability is

* Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 123–6, 157–61. Cf. this Journal, *ante*, p. 266.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 162–9 (2 figs.).

confined to several layers of the prismatic cells of the inner side of the lamellæ, and it is here that the continuity of the protoplasm from cell to cell was determined. A conduction of the irritation from one lamella of the stigma to the other takes place in the two species of *Martynia*, and in *Mimulus cardinalis*, but not in *M. luteus*. That the conduction does not take place through the vascular bundle was demonstrated by the fact that it is not affected by cutting the bundle.

Nectary of Galanthus nivalis.*—Prof. F. Delpino points out that Sprengel and H. Müller are in error in regarding the green streaks on the inner surface of the petals of the snowdrop as a nectary. They secrete no nectariferous fluid of any kind, but are simply "Saftmaale," or guides to the pollinating insect to find its way to the true nectary, which is a minute circular green pit or foveola on the summit of the ovary surrounding the styles.

Nectary and Aril of Jeffersonia.†—Dr. S. Calloni describes the nectaries in *Jeffersonia diphylla* (Berberidaceæ) as swellings at the base of each petal, which are closed glands formed by differentiation of the parenchyma in the course of the development of the petals. The torn aril with which the ripe seeds are provided, and no trace of which is to be seen in their early stage, is a true arillus resulting from a differentiation of the parenchyma of the funicle.

"Crazy" pollen of the Bell-wort.‡—Mr. B. D. Halsted states that the pollen of the large flowered bell-wort (*Uvularia grandiflora* Sm.) is of good size, smooth coated, nearly colourless, and in many ways well adapted for use in laboratory work with students. In the experiments conducted by the author, one of the culture slides lost a large part of the nourishing sugar solution by absorption into pieces of surrounding blotting paper, and the pollen-grains upon the under surface of the suspended glass cover produced tubes of very strange abnormal forms. Some germinated from the side, others from the end, while others still sent out tubes from both side and end. In some cases the pollen-grain looked as if it had undergone a process similar to that of the popping open of a grain of Indian corn. In others there was an amœba-like mass projecting from one side of the grain, having not less than a dozen arms extending in as many directions.

Anatomical studies on Mayaca.§—M. V. A. Poulsen states that the root of *Mayaca* Aubl. is adventitious, and comes from the lower part of the trunk. The intermediate zone of the cortex incloses a system of aeriferous chambers. The cells of the endoderm are uniformly lignified, as are also those of the pericambium successively as they advance in age. The aeriferous chambers in the trunk are very large, and present characteristic development with specialized cells in the septa. The leaves are small, and, as in *Lycopodium*, the epidermis on the two surfaces is similar, and does not contain chlorophyll.

The original paper (in Danish), is illustrated by four plates.

* Malpighia, i. (1887) pp. 354–8.
† Ibid., pp. 311–6 (1 pl.).
‡ Bot. Gazette, xii. (1887) pp. 139–40.
§ Overs. K. Danske Vid. Selsk., 1886, pp. 85–100 (5 pls.), French Résumé, pp. xxi.–iv.

β. Physiology.*

(1) Reproduction and Germination.

Fertilization of Epipactis latifolia.†—Mr. A. D. Webster states that all or nearly all his observations tend to show (1) that *Epipactis latifolia* is very imperfectly fertilized; (2) that, although visited by insects, cross-fertilization seldom takes place; and (3) that self-fertilization by the pollen falling spontaneously on the stigma is not uncommon.

That the plant is very imperfectly fertilized is evident from the small quantity of seed produced. Nineteen plants growing in consecutive order in one wood were examined, and out of a possible 492 capsules only 38 produced seed. That, although visited by insects, cross-fertilization seldom takes place, is proved by the following observations. Amongst insects of sufficient size to remove the pollinia that have been seen visiting the flowers of this *Epipactis*, may be mentioned the red-tailed humble bee and our common wasp, the latter, however, but very rarely. The author has observed the above-mentioned bee enter several flowers on two different plants without in any case removing the pollinia; also a red-tailed humble bee visiting sixteen flowers on a spike without removing any of the pollinia.

Self-fertilization by the pollen falling spontaneously on the stigma is not uncommon. The author has observed that the pollen-masses in a few days, or perhaps a week, after the flowers open, become swollen, or the particles of pollen disunited so as to protrude slightly beyond the sharp upper edge of the stigma. The pollen becomes friable, and before the plant withers, either spontaneously or by the action of the wind, falls on the stigma and other parts of the flower.

Influence of Ozone on Germination.‡—Herr A. Vogel states that strongly ozonized air seems to have no harmful influence on the germination of seeds. Milk and meat can be kept for a longer time in ozonized air without change than in ordinary air.

(2) Nutrition and Growth.

Transpiration and Assimilation in Leaves treated with Milk of Lime.§—In view of the mode of treatment of vines for the destruction of the *Peronospora*, the question is of some importance whether the functions of transpiration and assimilation are checked or prevented by the application to the leaves of milk of lime. From a series of experiments on the leaves of the horse-chestnut, cherry, and vine, Dr. G. Cuboni has come to the conclusion that it has no injurious effect.

(3) Movement.

Part taken by the Medullary Rays in the Movement of Water.‖—Dr. J. M. Janse has confirmed by experiment Godlewski's theory¶ that the living parenchymatous elements of wood take an active part in the movement of the transpiration-current. The objections made by various authors to the soundness of this hypothesis he regards as unimportant; and states that experiments show that the part taken by the medullary rays is connected with certain conditions:—a definite arrangement of the elements of the wood, greater power of resistance to filtration, and the unilateral action

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

† Bot. Gazette, xii. (1887) pp. 104–9.

‡ Bied. Centr., 1887, p. 142. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 516.

§ Malpighia, i. (1887) pp. 295–310 (1 pl.).

‖ Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 1–69 (1 pl.).

¶ See this Journal, 1886, p. 1016.

of the cells belonging to the rays—all of which are fulfilled in the wood. Although Dr. Janse's observations were made chiefly on Conifers, he does not think the results would have been essentially different had the wood of Dicotyledons been the subject of investigation.

(4) Chemical Changes (including Respiration and Fermentation).

Supposed Reduction of Nitrates by Barley and Maize. *—M. A. Jorissen gives the results of some experiments which he performed with a view of finding out whether nitrates are reduced by barley or maize. The grains were first placed for half an hour in a dilute solution of mercuric chloride; they were then washed in boiling water, and afterwards placed in boiling distilled water for twenty-four hours. The author then caused them to germinate in tubes previously sterilized, and when the rootlets were about a centimetre long they were placed in a 1 per cent. solution of potassium nitrate. At the end of twenty-four and forty-eight hours the liquid was examined for nitrous acid. No reduction was found to have taken place. This result is contrary to that obtained by Laurent and Schönbein. The author attributes the reduction which took place in their experiments to the presence of living organisms in the culture liquids.

Liberation of Nitrogen from its compounds, and acquisition of atmospheric Nitrogen by Plants.†—The conclusions arrived at by Mr. W. O. Atwater are the following:—(1) During the growth of peas, nitrogen is in most cases acquired from the air; but in some few cases where the conditions of growth are abnormal, there is either no gain in nitrogen or there is a slight loss. This loss is to be explained by the evolution of free nitrogen from the nutriment, or from the seeds and plants during germination and growth; it is probably a constant, and may cause considerable error in all the experiments. (2) Boussingault has found the amount of atmospheric nitrogen absorbed to be very small; but in his experiments the plants were not normally nourished, and probably, therefore, were less able to resist the action of denitrifying ferments or to absorb nitrogen from the air. (3) Numerous experiments have shown a slight gain or loss of nitrogen during germination and growth, but the failure of an experiment to show the acquisition of nitrogen from the air proves the non-assimilation of atmospheric nitrogen only on condition of the further proof that no nitrogen was liberated. (4) The liberation of nitrogen appears to be due in some cases, if not in all, to ferments. (5) The way in which the nitrogen is acquired is still a matter of doubt. (6) The experiments of Boussingault, and of Lawes, Gilbert, and Pugh, which have given the strongest evidence against the fixation of free nitrogen by plants, are possibly affected by the loss of nitrogen already referred to, by the exclusion of the action of electricity and of microbes, and by the fact that the plants were also for the most part poorly fed. (7) In the author's experiments ignited sea-sand was used for growing the plants in, and hence it is probable that the plants themselves and not the soil are factors in the acquisition of atmospheric nitrogen. (8) Lawes, Gilbert, and Warington have shown the great probability that leguminous plants, which appear to possess in a high degree the power of obtaining nitrogen from natural sources, induce the action of nitrifying ferments by which the inert nitrogen of the soil is made available. It is equally conceivable that the same plants and others may favour the action of nitrogen-fixing micro-organisms.

* Bull. Acad. R. Sci. Belg., xiii. (1887) pp. 445–8.
† Amer. Chem. Journ., viii. (1886) pp. 398–420. See Journ. Chem. Soc. Lond., 1887—Abstr., p. 515. Cf. this Journal, *ante*, p. 270.

γ. General.

Autumnal Changes in Maple Leaves.*—Messrs. W. K. Martin and S. B. Thomas give the results of certain investigations conducted in the botanical laboratory of Wabash College. The structure of the normal green maple leaf consists of the ordinary epidermal layer above and below, a single cell in depth, a single layer of rather elongated palissade-cells, and usually about three layers of spongy parenchyma, more closely packed than usual. The chlorophyll bodies are small, and thickly and evenly distributed throughout the mesophyll cells.

The first indication of the approach of autumnal changes is the withdrawal of the contents of the mesophyll-cells. The protoplasm seems to dispose of much of its substance in the manufacture of cellulose, and the chlorophyll-bodies are seen both to disintegrate and to blend together in large masses. In leaves which have become brown, a greater amount of cell-contents remains than in the red, the chlorophyll-bodies do not mass together so much, and the cell-sap is a dirty brown. In red leaves the cell-contents are even more reduced, some cells being almost empty, the remaining contents are mostly collected in masses of considerable size, and are often surrounded by a pellicle of cellulose. The cell-sap is coloured by the characteristic red colouring matter, erythrophyll. In yellow leaves the cell-contents are much like those of the red, but the cell-sap is colourless, and the chlorophyll-masses are stained yellow by xanthophyll.

Physiological Rôle of Vine Leaves.†—Herr H. Müller states that a large number of leaf-bearing shoots should be sacrificed during the ripening of the fruit. These leaves require a large quantity of sugar for their development and for the support of their respiration. In removing the old leaves during the ripening of the fruit, too great a loss of assimilating tissues need not be feared, becaue the old leaves have only feeble assimilating power, and are moreover in the shadow of the upper leaves. If two shoots are cut off and placed in darkness until all the starch has disappeared, then one of these simply placed in water, and the other injected with water under pressure, the latter will form starch much more abundantly than the former. The transformation of starch into sugar is similarly affected.

Influence of soil on the vegetation on the summits of the Alps.‡—M. J. Vallot states that the most interesting localities to study the influence of soil on the vegetation of the Alps are those where, in the midst of a uniform region, one finds a patch of soil of a different character. The Aiguilles Rouges which arise over Chamounix, opposite Mont Blanc, are formed of crystalline schist. On the other side, separated by a deep valley, rises the Buet, where the crystalline schist is covered by triassic and jurassic strata. At the Belvédère, the highest point of the Aiguilles Rouges, a small portion of sedimentary earth remains, and it is interesting to contrast the vegetation of the summit with that of the surrounding district.

The author then gives three lists of plants. One for the mica schist on the summit of the Belvédère, another for the calcareous schist of the Belvédère, and a third for the Buet.

The following plants are found only on the mica schist :—*Draba fladnizensis*, *Sempervivum montanum*, *Oxyria digyna*, *Carex curvula*, &c.; while *Ranunculus glacialis*, *Arabis alpina*, *Alsine verna*, *Campanula cenisia*, *Linaria alpina*, &c., are found on the calcareous, but not on the mica schist of the Belvédère.

* Bot. Gazette, xii. (1887) pp. 78–81.
† Ann. Agronom., xiii. p. 140. Cf. Journ. Chem. Soc. Lond., 1887, Abstr., p. 685.
‡ Bull. Soc. Bot. France, xxxiv. (1887) pp. 25–9.

Gummosis.*—Observations made by Dr. L. Savastano on *Acacia arabica*, *Phœnix dactylifera*, *Eucalyptus globulus*, *E. Sideroxylon*, *E. amygdalina*, *E. hemiphloia*, and *Fraxinus Ornus*, confirm the conclusion previously arrived at that this condition is comparatively rare in plants grown north of their proper zone of cultivation; and similar observations on the Amygdaleæ, Aurantiaceæ, vine, olive, *Quercus*, and *Acer*, show that any given species subject to gummosis is more liable to it in the southern than in the northern portion of its zone of cultivation.

Anæsthesia and Poisoning of Plants.†—Dr. F. Tassi records the results of about 100 experiments on the effect of a large number of anæsthetics and poisons on different plants. Among the general conclusions at which he has arrived is the existence of a property belonging to vegetable protoplasm analogous to that which in animals is called contractility, irritability, &c. Of the substances which are fatal to animals, some are poisonous, others anæsthetic, and others innocuous to plants. Among the latter are curare, and the poison of the viper and of the cobra. He observes also that the state of inertia or rigidity of flowers is often accompanied by a change of colour.

Humboldtia laurifolia as a myrmecophilous plant.‡—Prof. F. O. Bower states that the ants enter this plant through an opening formed by rupture of the superficial tissues, due apparently to pressure from within; they thus gain access to and hollow out the pith which had previously begun to decay. They are probably supplied with food from the numerous glands on the leaves. He could find no evidence that the symbiosis is of any advantage to the plant.

B. CRYPTOGAMIA.

Symbiosis of a Bacterium and Alga.§—Prof. A. Tomaschek records a singular instance of symbiosis in a slimy growth found on the walls of a greenhouse, which he found to consist of a Schizomycete in the zooglœa-form agreeing most nearly with *Bacillus megaterium*. A dirty violet or chocolate-brown colour was imparted to the mass by larger or smaller islands of a green alga (chlorophyllous protophyte), *Glœocapsa polydermatica*, imbedded in it. He regards the connection as an example, not of parasitism, but of true commensalism brought about by the needs of the bacterium for oxygen.

Cryptogamia Vascularia.

Rabenhorst's Cryptogamic Flora of Germany (Vascular Cryptogams).—The most recently published parts of this work (Parts 8–10), by Dr. C. Luerssen, complete the account of the Polypodiaceæ, and comprise also descriptions of the German species of Osmundaceæ, Ophioglossaceæ, and Rhizocarpeæ, and the commencement of a general description of Equisetaceæ. Every species, as well as the more important varieties, are illustrated by beautiful woodcuts, the descriptions and the lists of localities are very full, and nothing is omitted to make the work as full and accurate in every particular as could be desired.

Muscineæ.

Leaves of Mosses.‖—Sig. G. Arcangeli points out that a useful character for discriminating species of moss can be drawn from the fact that in some

* Nuov. Giorn. Bot. Ital., xix. (1887) pp. 101–3. † Ibid., pp. 29–104.
‡ Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 699.
§ Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 190–2.
‖ Atti Soc. Tosc. Sci. Nat., v. (1887) pp. 241–3.

forms the nervation of the leaves ends in a small projecting point or tooth, and in addition to this presents another small tooth pointing downwards below the apical tooth. This is the case in *Rhyncostegium striatum*, *R. rusciforme*, *Brachythecium salebrosum*, *B. velutinum*, *B. albicans*, and *B. reflexum*.

Analogous variations in Sphagnaceæ.*—M. C. Jensen states that in no other genus of mosses is the tendency of the individual species to vary more marked than in *Sphagnum*. It is not always possible to recognize the cause of these variations. Water appears to exercise the chief influence, then light or shade, and in some cases the temperature of the soil. The organs of the plant liable to variation are, firstly, the leaves, and then the branches, whether sterile or fructiferous. If the plant grows entirely in water, all the parts become larger and longer. These variations the author designates by the term *formæ immersæ*. Under the direct influence of the sun's rays the plants become more compact (*formæ compactæ et strictæ*). If the plant grow in the shade, it becomes more robust, and the leaves squarrose, (*formæ squarrosulæ*). The author also designates certain variations as *formæ falcatæ*, *formæ homophyllæ*, and *formæ tenellæ*.

By taking various species of *Sphagnum*, and tabulating them under the above divisions, the variation of the species taken can be seen at a glance. Take, for instance, *Sphagnum acutifolium* Ehrb. This species is represented in all the divisions, but especially well in *formæ tenellæ* and *compactæ*. In the first could be cited var. *fusca* Sch., *tenuis* Braithw., *rubella* Wils., and *gracilis* Russ.; and in the latter, var. *arcta* Braithw., *congesta* Gravet, and *Schimperi* Warnst. A *forma homophylla* also occurs, which might readily be confounded with *S. molle* Sull. The form *stricta* is well represented by the vars. *stricta* and *strictiformis* Warnst.; the *formæ immersæ* are rarer; to this belong vars. *plumosa* Milde, and *immersa* Schleich., while var. *squarrosula* Warnst. represents the *formæ squarrosulæ*.

Algæ.

Classification of Algæ.†—Mr. A. W. Bennett proposes some modifications in the existing systems of the classification of Algæ (including the chlorophyllous Protophyta), in accordance with their affinities. Too little importance has, he considers, at present been attached to degeneration or retrogression, which may be exhibited in the partial or complete suppression of either the reproductive or the vegetative organs.

He traces all the various forms of vegetable life to three lines of descent, represented by three distinct kinds of cell-contents—colourless, blue-green, and pure green. The first appears to originate in the Bacteria or Schizomycetes, from which are derived the whole group of Fungi. The second primordial type consists of unicellular organisms, in which the cell-contents are composed of a pale watery blue-green endochrome diffused through the protoplasm, without distinct chlorophyll-grains, starch-grains, or nucleus, the Chroococcaceæ, the simplest form of the Phycochromaceæ or Cyanophyceæ, which attain their highest development in the Nostochineæ, including the Oscillariaceæ, Rivulariaceæ, Scytonemaceæ, and Nostocaceæ. To them are probably related the Diatomaceæ, which the author regards as a simple form of life, probably not nearly connected with the Conjugatæ.

The third series, or Chlorophyllophyceæ, is the only one which has developed into the higher forms of vegetable life. It is characterized from the outset by the cells possessing a nucleus, starch-grains, pure chlorophyll,

* Rev. Bryol., xiv. (1887) pp. 33–42.
† Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 49–61.

and, in certain states, a true cell-wall of cellulose. The lowest family—the Protococcaceæ—exhibit further development in two directions, the perfection and differentiation of the individual cells, and the association of cells into colonies or cœnobes. The latter tendency leads to the Sorastreæ, Pandorineæ, and finally to the Volvocineæ. The further differentiation of the individual cell has advanced one stage in the Eremobiæ or Characiaceæ, from which are derived the Multinucleatæ, comprising the Siphonocladaceæ and Siphoneæ. The striving after a high development by the elaboration of a single cell culminates in *Vaucheria*, or in such forms as *Acetabularia*. Cell-division is already well displayed in the Confervoideæ isogamæ, including the Chroolepideæ, Ulotrichaceæ, Confervaceæ, and Pithophoraceæ. From them evolution appears to have taken place in three different lines:—(1) the Conjugatæ, including the Zygnemaceæ, Mesocarpeæ, and Desmidieæ, which evidently came to an abrupt conclusion; (2) the Phæosporeæ, which led, through the Cutleriaceæ and Dictyoteæ, to the Fucaceæ, the highest type of "oogamous" reproduction, consisting in the impregnation of a comparatively large oosphere by a number of minute antherozoids; the Syngeneticæ being regarded as a retrogressive offshoot from the Phæosporeæ; and (3) the Confervoideæ heterogamæ, including the Sphæropleaceæ, Œdogoniaceæ, and Coleochætaceæ, from which latter family the Pediastreæ are probably derived by retrogression. The Coleochætaceæ lead up directly to the highest type of structure attained by Thallophytes, the Florideæ, from the highest form of which we have probably several retrogressive branches, viz. the Nemalieæ, the Lemaneaceæ, and the Bangiaceæ; the author suggests that the Ulvaceæ may possibly be derived from the Bangiaceæ by further retrogression.

Cause of the Turbidity of Water.*—Dr. C. O. Harz describes a peculiar appearance in the water of the Schliersee, in Bavaria, commencing when it was covered by ice;—a dense turbidity, at first of a green or blue tinge, but becoming finally yellow-red or peach-coloured before finally disappearing. This was due to enormous quantities of a *Palmella*, probably *P. uvæformis*, which was attacked and finally completely destroyed by a peach-coloured micrococcus, *Clathrocystis roseo-persicina*. In addition were found also smaller quantities of *Beggiatoa alba*, *B. roseo-persicina*, *Chlorococcum gigas*, *C. botryoides*, *Conferva bombycina*, *Cylindrospermum macrospermum*, a *Raphidium*, *Scenedesmus acutus*, and *S. obtusus;* also several diatoms and *Oscillarias.*

Dissemination of Algæ by Fish.†—Further observations on this subject by Sig. A. Piccone confirm his previous conclusion as to the important part played by herbivorous fish in disseminating seaweeds by feeding upon them. The contents of the stomach and intestines of many species inhabiting the Gulf of Genoa were examined, and found to contain large quantities of different species of seaweeds, and very frequently the fertile portions. Far the most important agent in this process is *Box Salpa*, in which were found the remains of no fewer than fifty species of marine algæ. In the stomach and intestines of *Sargus Rondeletii* were found twenty-four species, and smaller quantities in *Sargus annularis*, *Pagellus Mormyrus*, *Labrax Lupus*, *Scomber Scombrus*, *Scorpæna Porcus*, *Labrus* two species, and *Belone Acus;* while *Box Boops*, *Cantharus lineatus*, *Pagellus Acarne*, *P. erythrinus*, *Chrysophrys aurata*, *Dentex vulgaris*, *Xyphias gladius*, *Zeus faber*, *Scorpæna*

* SB. Bot. Ver. München, Dec. 20, 1886. See Bot. Centralbl., xxx. (1887) pp. 286–7, 331–2.

† Nuov. Giorn. Bot. Ital., xix. (1887) pp. 5–29. Cf. this Journal, 1885, p. 843.

Scrofa, *Trigla Hirundo*, *Labrus* species, *Merluccius vulgaris*, and *Raia* species, showed no indications of phytophagy. A gasteropod, *Aplysia* species, was also found to feed on Algæ.

New Diatoms.*—From fossil marine deposits in Barbadoes, Dr. H. H. Chase and Mr. C. W. Walker describe the following new species:—*Triceratium Weissflogii*, *T. fractum*, *T. granulatum*, *T. caribæum*, *T. minutum*, and *Stephanopyxis pulcher*.

Fungi.

Prolification in the Mycelium of Fungi.†—This phenomenon, which Herr P. Lindner defines as the bulging of the septum which divides two cells into one of the cells, and then growing into a filament inclosed in it, has been at present observed, among fungi, in *Saprolegnia*, *Chætomium*, and *Inzengæa*. Herr Lindner now describes its occurrence in several mould-fungi, including *Epicoccum purpurascens*, *Alternaria* species, and *Botrytis cinerea*. The phenomenon is especially observable in both the aerial hyphæ and in the mycelial filaments which grow within the substratum of *Epicoccum purpurascens*, a somewhat rare fungus, distinguished by its intensely purple-red mycelium, belonging probably to the Ascomycetes, but of which the conidial mode of reproduction only is at present known.

Saccharine Substances in the Phalloideæ.‡—Sig. F. Morini gives the following as the main results of his investigations on several species of fungi belonging to this group:—

The mature gleba of *Clathrus cancellatus* contains dextrose and a sugar which is probably mycose or trealose; it also exhibits a special gummy mucilage. In the gleba of *Phallus impudicus* the glucose consists chiefly of dextrose; levulose was in fact observed in much smaller quantities. In addition, a gummy substance is found in some abundance homologous to that in *C. cancellatus*. In the gleba of *Mutinus caninus*, the glucose is accompanied by a small quantity of a mucilaginous substance. The receptacles of *C. cancellatus*, and *P. impudicus* contain levulose and smaller quantities of dextrose and trealose; that of *M. caninus* glucose, and a very small quantity of trealose.

The glucoses of the gleba owe their origin chiefly to metamorphosis of the mucilaginous substance produced by a gelification of the membrane of the sporigenous hyphæ. The glycogen is mostly transformed into glucose, and this is the ordinary form in which the carbohydrates are transferred from one part to another in the course of development.

Tubercular Swellings on the Roots of Leguminosæ.§ — Prof. H. Marshall Ward finds that the tubercles on the roots of the Leguminosæ are due to the action of a parasitic fungus. Not only has he produced the tubercles by infection from without, but he has also found the infecting agent, and repeatedly seen and figured the infecting hypha passing down inside a root-hair and across the cortex of the root into the young tubercle. Here the hyphal branches bud off yeast-like cells, which are extremely minute and numerous, and resemble bacteria at first sight; they differ in their mode of multiplying by budding. The action of the minute germ-like bodies causes the protoplasm of the cells of the root to assume plasmodium-like characters, and induces the flow of nutritive substances to these cells,

* Chase, H. H., and Walker, C. W., 'Notes on some new and rare Diatoms,' series ii., iii., 12 pp. and 3 pls., 1887.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 153-61 (1 pl.).

‡ Malpighia, i. (1887) pp. 369-83.

§ Proc. Roy. Soc. Lond., xlii. (1887) p. 331. Cf. this Journal, *ante*, p. 610.

and hypertrophy results. On the decay of the tubercles the germ-like bodies pass into the soil (where they can always be found) and infect other roots; it is very probable they may be of extreme importance in agriculture.

Phosphorescent Fungus.*—Abbé J. Dulac has observed two tufts of *Agaricus olearius* very strongly phosphorescent, and was able to determine that the fungi were parasitic on the roots of *Poa pratensis.*

Mycelites ossifragus—a Fungus in Bone.†—Prof. W. Roux had his attention directed to striations in sections of a rib of *Rhytina stelleri.* These bands have parallel contours, and consist of a substance slightly more refractive than the surrounding osseous tissue; they became more obvious after the section had been treated with 5 per cent. nitric acid; and after treatment with iodine and sulphuric acid a blue coloration became apparent. The author gives a detailed account of his observations and experiments, and states that, on showing them to Prof. Hasse, the latter recognized the bands as having been seen by him in fossil vertebræ from various strata as low as triassic deposits.

On coming to the conclusion that he had to do with something not belonging to the osseous tissue itself, the animal kingdom was first thought of, but every suggestion was found to lead to difficulties; the *Leptothrix buccalis* and its influence in producing caries of the teeth was so far a happier suggestion, that it led to the vegetable kingdom being proposed for study; the canals in the bone agreed in thickness, form, and mode of branching with the lower plants; and fungi present, in their mycelial filaments, thick plexuses like those found in the bone; fungi are also known to force their hyphæ into organic substances. As the fungi are classified by the characters of their sporangia, attention was given to the special rounded structures in the bone which were seen to have the form, some of unripe, and some of ripe spores of the Phycomycetes; going further, they appear to present a resemblance to *Saprolegnia;* waiting for further discoveries to settle this question more definitely, the growth may be called *Mycelites ossifragus.*

Brief reference is made to the canals in the shells of Lamellibranchs and Gastropods, which Wedl supposed to be due to algæ, but Kölliker (who extended the observation to a number of other forms) to fungi; and to the observations of Duncan and Moseley on *Achlya.*

Peronospora umbelliferarum on the Vine.‡—By repeated experiments, Sig. P. Pichi has been able to obtain on the lower surface of leaves of the vine, infection from zoosporanges of this fungus obtained from *Ægopodium Podagraria.*

Propagation of Peronospora viticola by means of Oospores. §—M. E. Prillieux has attempted, together with M. Fréchou, to germinate the oospores of this *Peronospora,* and has found them generally emit well-developed tubes. Sometimes one of these tubes becomes directly fructiferous and bears conidia.

M. d'Arbois of Jubainville examined the leaves of the vine on the first appearance of conidiferous filaments, and noticed small brown spots which corresponded to the points where, on the other side, small particles of earth adhered. These spots gradually increased in size, and at the end of a month produced the fructification of *Peronospora.*

* Rev. Mycol., ix. (1887) pp. 12–3.
† Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 227–54 (1 pl.).
‡ Atti Soc. Tosc. Sci. Nat., v. (1887) pp. 258–9.
§ Bull. Soc. Bot. France, xxxiv. (1887) pp. 85–7.

The author concludes by stating that those vines in which the leaves touch the surface of the soil are attacked by the parasite first and with the greatest intensity.

Amblyosporium.* — In describing a new species, *Amblyosporium bicollum*, parasitic on *Lycoperdon gemmatum*, M. J. Costantin gives the following as the generic characters of *Amblyosporium* (Mucedineæ):— (1) The foot is very long, and supports a head formed of conidia, which differentiates itself from the summit towards the base of the filaments that attach themselves to the foot. (2) The capitula are successively of two different colours. (3) It is further characterized by its development on Hymenomycetes.

Celery-leaf Blight.† —Mr. B. T. Galloway states that this disease, due to the fungus *Cercospora Apii* Fres., annually destroys about one-half of the celery planted in Columbia. Frequent showers and heavy dews followed by hot sunshine favour the growth of the fungus. It usually appears about July 1st, and on the approach of cool weather, which usually comes on in September, the fungus gradually disappears. When fresh the conidia germinate readily (in three hours) by sending out a delicate colourless thread from each cell. So long as the celery leaves are kept dry but few of the conidia germinate, but if the leaves are frequently moistened, the fungus quickly destroys them. Celery protected from the direct rays of the sun, either by natural means, as planting under trees, or by screens made for the purpose, is rarely attacked by the parasite.

On September 26th, 1886, several healthy celery plants that were growing in the open air were lifted, and planted in the greenhouse. About one week later sowings of the conidia of *C. Apii* were made upon the leaves of several plants. Fifteen days later, the leaves where the sowings had been made showed pale-green pustules. Owing to the cool weather which came on about the time the pustules made their appearance, the fungus made no further progress, except several spots which showed the brownish hyphæ, but no conidia. The plants upon which no sowings had been made remained healthy. A form of *C. Apii* is quite common on *Pastinaca*, but is quite distinct from that on cultivated celery. Mr. Ellis suggests the name *Cercospora Pastinacæ* for the form on *Pastinaca*.

Cyphella.‡—From a careful examination of the structure and life-history of *C. endophila*, found on dead branches of *Phytolacca dioica* in the Neapolitan territory, Dr. O. Mattirolo separates the genus *Cyphella* entirely from *Cantharellus*, with which it had been supposed by Fries to be allied, and places it near to *Corticium* and *Thelephora*.

Parasitism of Agaricus melleus.§—A series of experiments made by Dr. L. Savastano on the nature of the parasitism of this fungus on a number of trees, leads him to the conclusion that it is not a primary cause of disease, as it does not attack healthy plants, but only such as are already in an unhealthy condition.

Fungi parasitic on Camellia.‖—Sig. J. Passerini enumerates and describes the following new species of fungi parasitic on *Camellia japonica*, chiefly on the dry branches :—*Sphærulina Camelliæ*, *Phoma tenuis*, *P. tecta*, *P. ejiciens*, *P. Camelliæ*, *P. longicruris*, *Macrophoma Camelliæ*, *M. japonica*,

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 30–3.
† Bot. Gazette, xii. (1887) pp. 66–7.
‡ Atti R. Accad. Sci. Torino, xxii. (1887) pp. 355–61 (1 pl.).
§ Nuov. Giorn. Bot. Ital., xix. (1887) pp. 97–100.
‖ Rev. Mycol., ix. (1887) pp. 145–6.

Ascochyta minutissima, *Hendersonia Camelliæ*, *Rhabdospora advena*, and *Pestalozzia Camelliæ*.

Parasitism of Tuber.*—Dr. O. Mattirolo has established the fact that some rhizomorphs parasitic on roots perfectly resembling those known as mycorhiza by Frank † and others, give rise, in circumstances not accurately defined, to receptacles of species of *Tuber*, especially to *T. excavatum* Vitt. and *T. lapideum* n. sp. In both these species are internal cavities formed by a depression of the peridium, and opening externally by an aperture. This winding cavity is clothed by a number of dark-brown filaments united lengthwise into bundles, identical with the rhizomorphs of many genera of fungi. These filaments were determined by the author to proceed indubitably from the pseudo-parenchyma of the peridium, the continuity of the hyphæ being, however, lost with age. From the cavity in the receptacle these rhizomorphous hyphæ extend in all directions, forming a mycorhiza, in all respects resembling that found on the roots of Cupuliferæ, The parasitism of the truffle on roots Dr. Mattirolo considers to be amply demonstrated.

Chætomium.‡—The reproductive structure of this genus of Ascomycetes having been differently interpreted by different observers, the life-history has again been subjected to careful investigation by Herr F. Oltmanns. The species most fully worked out is *C. Kunzeanum*, grown on decoction of fruit. From the spore proceeds, as described by Zopf, a vesicle, from which spring the mycelial filaments spreading in all directions and branching abundantly in favourable nutrient solutions. The filaments are smooth or torulose according to the conditions of growth.

From the mycelium are developed undoubted ascogones, in which two spiral bands can be clearly distinguished; the coils may either be elevated above the pedicel or may embrace it; the pedicel is occasionally wanting, apparently an abnormal structure. In many cases the existence of a pollinodium can be distinctly made out, agreeing in essential points with that of *Eurotium*. The pollinodium appears always to spring from the pedicel of the carpogonium ; but its presence is often very uncertain; and in other cases it is clearly wanting, always when the carpogonium is coiled round its own pedicel.

The envelope, in which the ascogone is eventually completely inclosed, originates from branches of the hyphæ out of which the ascogone springs. The result is the production of a roundish ball with comparatively smooth surface, from which project the separate hairs characteristic of the genus; and the wall of the perithecium is then fully formed inclosing the archicarps. The author never saw perithecia which did not inclose an ascogone; but several ascogones may be inclosed in a common envelope. The development of the perithecium may take place in four different ways, which, however, run into one another, viz.:—(1) The hyphæ which constitute the envelope spring from immediately beneath the ascogone, as its pedicel; (2) Hyphæ are formed from the entire pedicel which interweave to form the envelope; (3) The pedicel of the ascogone and the adjacent hyphæ form numerous filaments; (4) The enveloping hyphæ are formed in large numbers before the production of the ascogone, which is often pushed in at a much later period.

From careful longitudinal sections of perithecia, which are very difficult

* Atti R. Accad. Torino, xxii. (1887) pp. 464–72, and Malpighia, i. (1887) pp. 359–69 (1 pl.).

† See this Journal, 1886, p. 113.

‡ Bot. Ztg., xlv. (1887) pp. 193–200, 209–18, 225–33, 249–54, 265–71 (1 pl.). Cf. this Journal, 1882, p. 376.

to obtain, at various stages, it is seen that at a certain period the ascogone breaks up into a mass of cells. The wall of the perithecium becomes now differentiated into an outer brown layer and an inner layer, the cells of which continue to increase in size, and rhizoids are formed from the lower portion, distinguished by their brown colour and irregular curving. A cavity is now formed in the central group of cells, bounded by the cells formed out of the ascogone, the upper layers of which disappear, while the lower layers remain. The cells of the walls of the perithecium which bound the cavity elongate into tubes which are periphyses, and those which still remain of the ascogone-cells also elongate vertically into filaments, which constitute a cushion, and from the rods which form this cushion are developed the asci. There are no paraphyses. As the asci are developing, an opening is formed to the perithecium, before the ascospores are fully developed. The mode in which the ascospores escape from the asci is not certain, but the perithecium becomes gradually filled with them, fresh asci being constantly formed. The author regards the "nucleophyses" of Zopf as simply periphyses.

The life-history was also followed out of *C. bostrychodes*, *murorum*, *pannosum*, and *crispatum*, differing only in unimportant points from that of *C. Kunzeanum.*

Gonidia are freely formed in cultures which have exhausted their nutrient solution. They have no connection with the perithecia.

As regards its systematic position, the author considers *Chætomium* as most nearly allied to *Melanospora.*

Mycorhiza.*—M. H. Lecomte states that he has found mycorhiza on the roots of various trees, particularly the beech, chestnut, oak, and hazel. On the roots of the hazel conidia and two perithecia have been observed. The first perithecium, found in September, was only 35 μ in diameter; the second, observed in November, was nearly spherical, and had a diameter of 46 μ. The perithecium was composed of pseudo-parenchyma. When pressed five brownish spores escaped. The spores were each formed of a thread of four cells, and resembled certain spores of *Perisporium.* Their length was 12 μ. The conidia were borne by colourless filaments; some were terminal, and some inserted laterally on the filaments. The conidia were elongated, and composed of two cells. Their length was about 14 μ.

The author states that it is not possible to actually determine the true affinities of this fungus, although in a great many of its characters it approaches the Perisporiaceæ.

New pathogenous species of Mucor.†—In addition to the only two pathogenous species of *Mucor* hitherto known, *M. rhizopodiformis* and *corymbifer*, Herr W. Lindt now describes two others, *M. pusillus* and *ramosus.* The former is distinguished by its very small size, the sporangiophore rarely exceeding 1 mm. in length. *M. ramosus* resembles *M. corymbifer*, but has larger spores. The infection-experiments were made on rabbits; a *Mucor*-mycosis resulting, altogether different from an *Aspergillus*-mycosis, and presenting the same pathological characters as that of the two species already known.

Fungous Diseases of Plants.‡—Mr. W. B. Grove finds that the *Eucharis* disease is due to the attacks of *Saccharomyces glutinis*, which attacks also

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 38-9. Cf. this Journal, 1886, p. 113.

† Lindt, W., MT. üb. einige neue pathogene Schimmelpilze (1 pl.), Leipzig, 1886. See Bot. Ztg., xlv. (1887) p. 204.

‡ Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 700.

other bulbs besides those of *Eucharis.* The fungus which occurs in the two forms of *Æcidium depauperans* and *Puccinia ægra,* is exceedingly destructive to cultivated species of *Viola.*

Tubercles on Ruppia rostellata and Zannichellia polycarpa produced by Tetramyxa parasitica.*—Dr. E. Hisinger has examined the structures produced by this Myxomycete. The cycle of development was fully followed out, including the formation of the tetraspores. The parasite attacks in the first place the youngest and tenderest tissues of the host, and the course of injury is very similar to that produced by *Plasmodiophora Brassicæ.*

Protophyta.

Oidium albicans.†—Dr. H. C. Plaut finds that this organism developes by sprouting and by the formation of mycelia from gonidia. The resting spores described by Grawitz and others he suspects to be merely conditions of involution, while the sporangium of Baginski is undoubtedly an involution form. The author next discusses *Monilia candida* Bon., growing on rotten wood. This, transferred to the mucosa of the crop of fowls and pigeons, was found to be indistinguishable from *Oidium albicans.*

Cultivations made from such material always retained the biological and physiological characteristics of the true *Oidium* cultures. The inference drawn is that *O. albicans* and *Monilia candida* Bon. are identical, and the author proposes that the former should be known as *Monilia candida.*

This organism is easily destroyed by sublimate solution, and is not transferable to the healthy mucous membrane of animals with a "strong constitution."

Heterocystous Nostocaceæ.‡—The concluding part of MM. Bornet and Flahault's exhaustive account of the heterocystous Nostocaceæ contained in the principal French herbaria is devoted to the tribes Sirosiphoniaceæ and Scytonemaceæ. The former are characterized by the cells dividing in the direction of the length of the trichome, and by branches resulting from the development of one of the collateral cells formed by this division. The sheath may be either closed or continuous; only in *Mastigocoleus* do certain branches terminate in hairs. The heterocysts occupy the place of an entire cell when the trichome is formed of cells not divided longitudinally; otherwise at the expense of one of the peripheral collateral cells. Seventeen species are described in detail, belonging to five genera, growing in stagnant water or on damp rocks, several in thermal springs, only one in salt water. The genera *Mastigocoleus*, *Hapalosiphon*, *Stigonema* (including *Sirosiphon*), and *Capsosira* make up the subtribe Stigonemeæ, distinguished by having a definite outline; the subtribe Nostochopsideæ, in which the sheaths coalesce externally into an amorphous gelatinous mass, comprises only the monotypic genus *Nostochopsis* from America and Sumatra.

In the Scytonemaceæ the trichomes never terminate in hairs, and the cells never divide longitudinally. The filaments are simple only in *Microchæte;* in the other genera branches emerge from the sheath either immediately below a heterocyst, or from the middle of an interval between two; the sheath is continuous, and frequently coloured; the heterocysts are intercalary or basilar, solitary or in rows. Seven genera are described,

* Meddel. Soc. pro Fauna et Flora Fennica, 1887, 8 pp. and 10 pls. See Rev. Mycol., ix. (1887) p. 168.

† Plaut, H. C., 'Neue Beiträge zur systematischen Stellung des Soorpilzes in der Botanik,' 32 pp., 12 figs., 8vo, Leipzig, 1887.

‡ Ann. Sci. Nat.—Bot., v. (1887) pp. 51–129. Cf. this Journal, *ante*, p. 449.

including forty species, of which only three are marine. In *Microchæte*, *Scytonema* (including *Petalonema*), *Hassallia*, and *Tolypothrix*, the trichomes are solitary in their sheaths; in *Desmonema*, *Hydrocoryne*, and *Diplocolon*, from two to six trichomes are frequently included in a common sheath.

Beggiatoa alba.*—Prof. W. Hillhouse finds this organism in the coccus form and in that of rodlets and spirals, and displaying swarming and even creeping movements like those of the Oscillariaceæ. It may be grown for laboratory purposes on fragments of (vulcanized) indiarubber tubing kept in water, on which it will usually appear spontaneously after the lapse of a few months.

Chemical Action of Bacterium aceti.†—Mr. A. J. Brown gives some further notes on the chemical action of *Bacterium aceti*. The oxidizing action of the pure ferment on mannitol has been described, showing that this carbohydrate is completely decomposed, and that a sugar (levulose) is the main product formed from it. As dulcitol is an isomerid of mannitol, it appeared interesting to ascertain if *B. aceti* had any action on it, more especially as, according to Carlet, dulcitol yields a $C_6H_{12}O_6$ sugar on oxidation with dilute nitric acid. In the several experiments made, however, not the least action of the ferment on the dissolved dulcitol could be detected.

Action of B. aceti on glycol.—The action of *B. aceti* on a 2 per cent. solution of the dihydric alcohol glycol was next studied. The solution was sterilized and inoculated with the ferment in the usual manner. At first the ferment grew freely, but the action was evidently over in five weeks' time. On opening the flask the solution was found to be slightly but distinctly acid; a portion was evaporated to a small bulk and filtered, and the absence proved of any acid giving an insoluble lime salt. The rest of the solution was boiled with calcic carbonate, filtered, and the lime salt so formed precipitated by excess of alcohol. The precipitate was dried, and a determination of the lime made. From the amount of lime present it seemed probable that this precipitate was glycollate of calcium, and a second experiment confirmed this opinion. The action of the ferment on glycol may be represented simply thus:—

$$CH_2(OH)\cdot CH_2(OH) + O_2 = CH_2(OH)\cdot COOH + OH_2.$$

Action of B. aceti on glycerol.—The action of *B. aceti* on a 5 per cent. solution of the trihydric alcohol glycerol was next tried. From the first the bacteria increased with remarkable freedom, and after the expiration of eleven weeks, when the flask was opened, there appeared to be a larger growth of the ferment, both in the liquid and as a deposit at the bottom, than had previously been observed in any other experiment with *B. aceti*. At the end of the experiment, titration of a portion of the solution showed that there was 0·114 per cent. acid present calculated as acetic acid. It appeared from the several experiments made that the action of *B. aceti* on glycerol is to decompose it into carbonic acid and water, the only other product of the action being a very small amount of an acid the nature of which is undetermined.

Action of B. aceti on erythrol.—Solutions of this tetrahydric alcohol in yeast-water, both with and without calcic carbonate, were submitted to the action of *B. aceti;* but although the ferment grew freely, no action on the erythrol could be detected. The fact that erythrol is not acted on by *B. aceti* is interesting, because this same substance is oxidized by platinum-black to erythric acid.

It will be noticed, therefore, that not only is *B. aceti* unable in some

* Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 701.
† Journ. Chem. Soc. Lond., 1887—Trans., pp. 638–42.

cases to oxidize a compound which is oxidized by platinum-black, but also that in the action of the ferment and of platinum-black on the same compound, the products formed in these actions usually differ.

The author concludes by noting the action of the ferment on mannitol prepared from manna, and on the mannitol formed by the action of sodium amalgam on dextrose. He states that there can be little doubt that the two compounds are identical.

Cellulose formed by Bacterium xylinum.*—Mr. A. J. Brown has endeavoured to ascertain whether cellulose formed by the ferment from levulose would yield a dextro-rotatory sugar on treatment with sulphuric acid like ordinary cellulose, or whether a levo-rotatory sugar would be formed. In order to ascertain this, a membrane of the ferment was grown in a yeast-water solution of levulose prepared from pure inulin. The author concludes by stating that the cellulose formed from levulose by *B. xylinum* yields a dextro-rotatory sugar on hydrolysis in a similar manner to ordinary cellulose; and a way of converting a levo- into a dextro-rotatory sugar is thus shown.

Anaerobic culture of aerobic Bacteria.†—According to Prof. M. M. Hartog and Mr. A. P. Swan, *Bacillus subtilis* will germinate in appropriate nutritive solutions, and form its "Kahmhaut" and spores, when oxygen is excluded from the space not occupied by the liquid, and replaced by carbon dioxide. The lactic organism of Pasteur, usually aerobic, will also develope and grow in suitable solutions during or after alcoholic fermentation induced by *Saccharomyces*, after the oxygen must have been used up and replaced by carbon dioxide.

Chemical reaction for Cholera Bacteria.‡—Dr. O. Bujwid states that the addition of a 5–10 per cent. hydrochloric acid to a bouillon cultivation of comma bacilli produces, in a few minutes, often in a few seconds, a red-violet colour. The colour increases for half an hour, and in a bright light becomes brownish. The staining is more evident if the cultivation be still warm. The reaction does not take place in impure cultivations. With Finkler-Prior's comma bacilli a similar but more brownish stain takes place, but after a longer time. The reaction which may be effected with other mineral acids does not affect many other kinds of bacilli.

Changes induced in water by the development of Bacteria.§—Sig. T. Leone has already demonstrated that the number of micro-organisms in a typically pure water, such as the Maugfall, near Munich, although at first small, yet on standing gradually increases to a maximum, and afterwards rapidly decreases. The development of bacteria induces certain chemical changes in the water; thus the quantity of oxidizable organic matter gradually decreases, whilst the proportion of ammonia increases to a maximum, and then decreases owing to its oxidation into nitrites and nitrates; on this account, the time which elapses between the taking of a sample and its analysis is an important factor. The consequent changes are divisible roughly into two distinct periods: the first, in which the organic matter is decomposed with production of ammonia; and the second, in which this is subsequently oxidized. It is further shown, on the other hand, that certain micro-organisms seem to act as reducing agents, reconverting the nitrates

* Journ. Chem. Soc. Lond., 1887—Trans., p. 643.
† Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 706.
‡ Zeitschr. f. Hygiene, ii. (1887) p. 52.
§ Gazzetta, xvi. pp. 505–11. See Journ. Chem. Soc. Lond., 1887—Abstr., p. 615.

into ammonia; and even the same organisms, according to the conditions, may either have an oxidising or a reducing function. In the first phase, when the nutritive matter is readily oxidizable and assimilated, the micro-organisms thrive at its expense, the process of nitrification being materially assisted by atmospheric oxygen; in the second phase, on the other hand, the necessary oxygen is derived from the nitrates; thus a change, seemingly of reduction, is induced.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Thury's Multiocular Microscope.—Prof. M. Thury has devised a Microscope (figs. 201 and 202) for enabling several observers to view the same object without having to change their seats. The following is a translation of the description which he sends us:—

"It is well known how tedious demonstrations with the ordinary Microscope are in consequence of the professor and his pupils having to continually change places. The Microscopes with two or three tubes, designed by M. Nachet (figs. 203 and 204) [and that of Prof. Harting,† fig. 205] obviate this inconvenience, but at the expense of a deterioration of the image, which is the more objectionable in consequence of its increasing rapidly with the power of the objective. This essential defect arises from the injurious influence of the edge of the prism, always imperfect, which occupies a diametral position relatively to the objective, disturbing a zone in the latter of constant size, which has therefore a greater influence on the image according as the objective has a smaller diameter.

It seemed to me that these inconveniences might be avoided, if in place of dividing the image between different observers it was received entire by a total-reflection prism, and by a movement of the prism passed successively to the different oculars of a Microscope with several tubes.

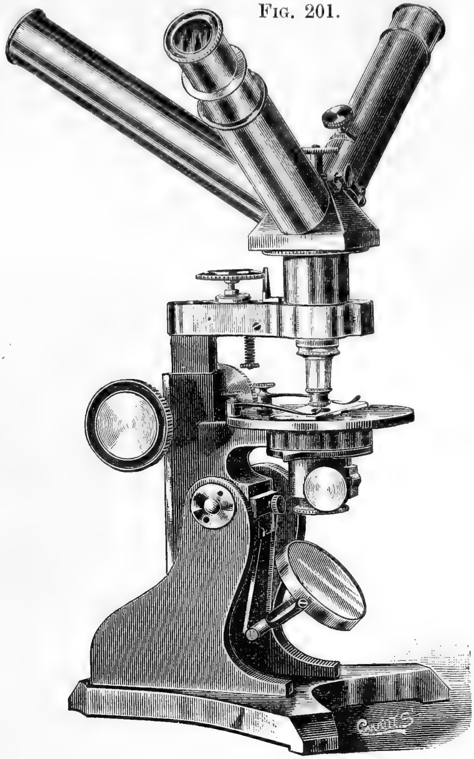
In consequence of the aberrations of colour and form which always take place in the case of prisms, the reflected image cannot be as perfect as the image obtained without it, but the difference is hardly appreciable. For instance, a Hartnack No. 9 objective which shows the beads of *Pleurosigma angulatum* with central light in the ordinary Microscope, shows them also, a little less distinct only, after reflection by the prism. A mirror of silvered glass would remedy this defect but at the expense of diminished permanence of the reflector.

The position of the prism P is shown in fig. 202. It is placed at a little distance behind the objective so as to diminish the effects of aberration, which are at their maximum when the prism is immediately behind the objective, as is necessarily the case when the image is multiplied in the manner hitherto adopted. The stage of the Microscope being horizontal and the optic axis of the objective consequently vertical, the prism is arranged to turn round a vertical axis situated in the prolongation of the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

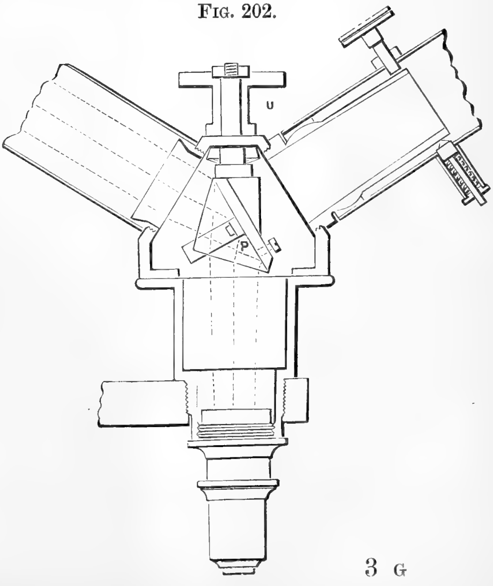
† Harting, P., Das Mikroskop, 1859, p. 780 (1 fig.).

FIG. 201.



axis of the objective. The prism is inclined on its axis of movement so as to reflect the light in a direction making an angle of 30° with the horizon.

FIG. 202.

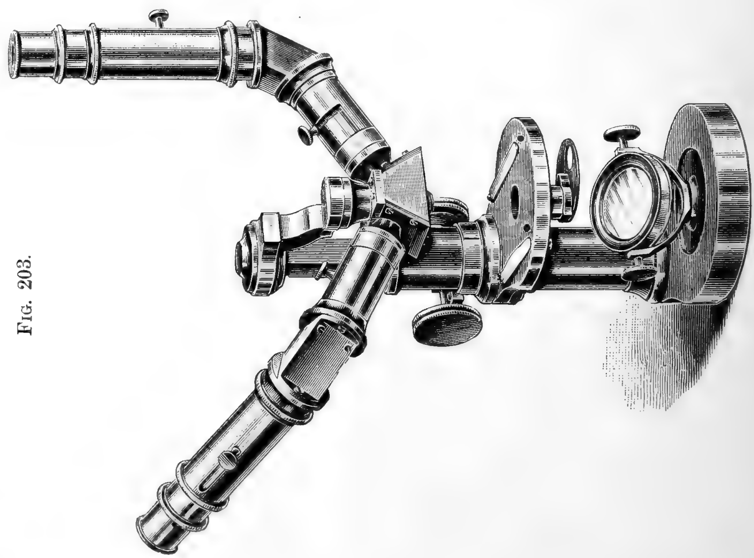


There are two tubes each with an eye-piece inclined about 60° to the vertical, and which can be placed opposite each other in the same vertical plane or in two planes at right angles. If the Microscope is intended for three persons there is a middle tube with two lateral ones at right angles with it.

All the tubes except one have an arrangement for focusing by the eye-piece, so that each observer may adjust the instrument to his own sight once for all.

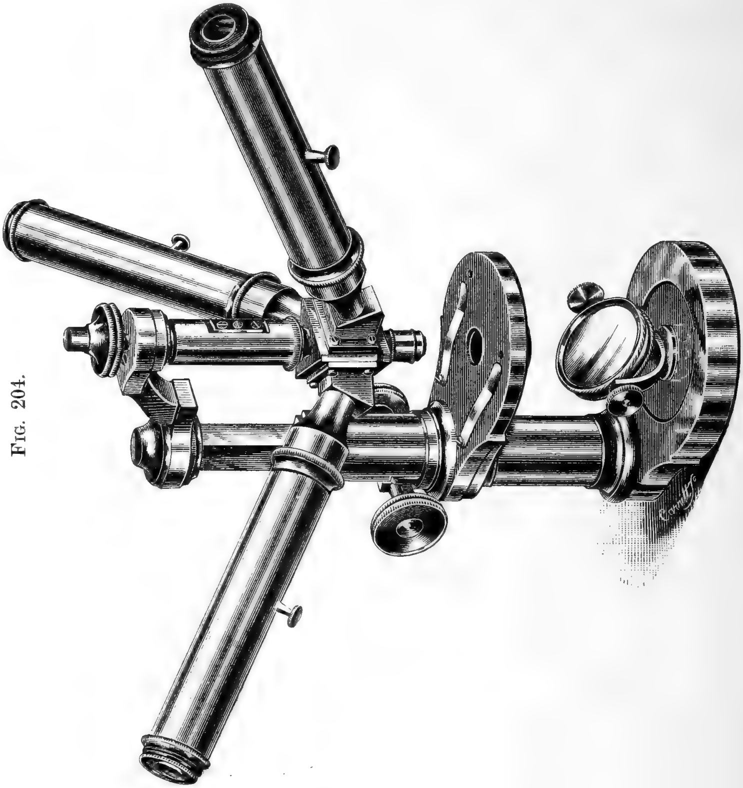
The possible defect of centering of the objectives, in consequence of which the image fails to occupy the same situation in the field of the different eye-pieces, is remedied by allowing the inclination of the tubes to be

Fig. 203.



NACHET'S MICROSCOPE À DEUX CORPS.

Fig. 204.



NACHET'S MICROSCOPE À TROIS CORPS.

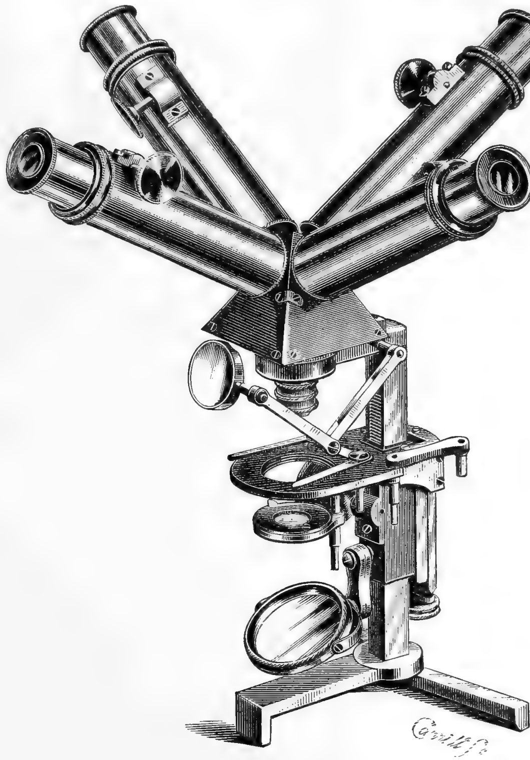
slightly varied, which makes the position of the images identical. There are also stops to limit at pleasure the movement of the prism.

By turning the prism by the milled head at U the image is transferred instantaneously from one tube to the other.

I hope that the new arrangement will render good service to the laboratories where microscopical anatomy is taught."

In some of the earlier forms of Stephenson's Binocular Microscope the upper prism box was made to rotate on the optic axis, carrying with it the

FIG. 205.



HARTING'S QUADRIOCULAR MICROSCOPE.

body-tubes, so that a circle of observers could view the object successively. Prof. Thury's plan, however, avoids the loss of time involved in swinging the tube round, and, what is more important, especially in the case of moving objects, in readjusting the focus for each observer.

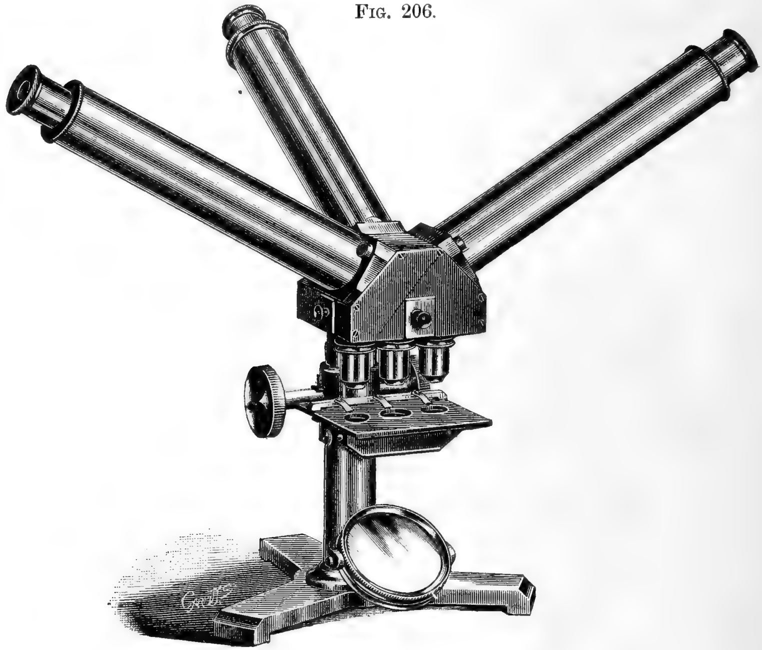
Ahrens's Triocular Microscope.—We cannot be sure that we fully appreciate the rationale of this instrument made by Mr. C. D. Ahrens (fig. 206), but it seems none the less necessary to notice it here if we are to maintain our original intention of recording such designs as have been considered sufficiently practical to be actually manufactured. Moreover, all classes of scientific bodies—zoologists, botanists, horticulturists, medical men, &c.—exhibit and record the abnormalities of their respective branches.

The Microscope consists, as will be seen, of a stand with three bodies

and three objectives, over which are three prisms, which deflect the rays at angles of about 45°.

In order to make use of one mirror only, Mr. Ahrens fits beneath the stage the arrangement of prisms shown in fig. 207, consisting of one equi-

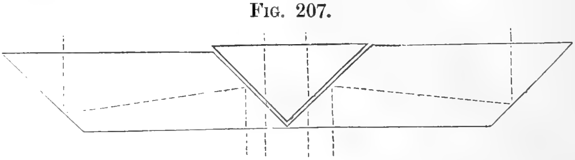
Fig. 206.



lateral and two rhomboidal prisms. These divide the rays from the mirror, sending part into each of the side prisms whence they are reflected into the two lateral objectives.

A Microscope with several bodies and *one* objective so that the *same object* may be viewed by several observers (as in the forms above described) has obvious uses, while a Microscope with two bodies and *two* objectives is

Fig. 207.



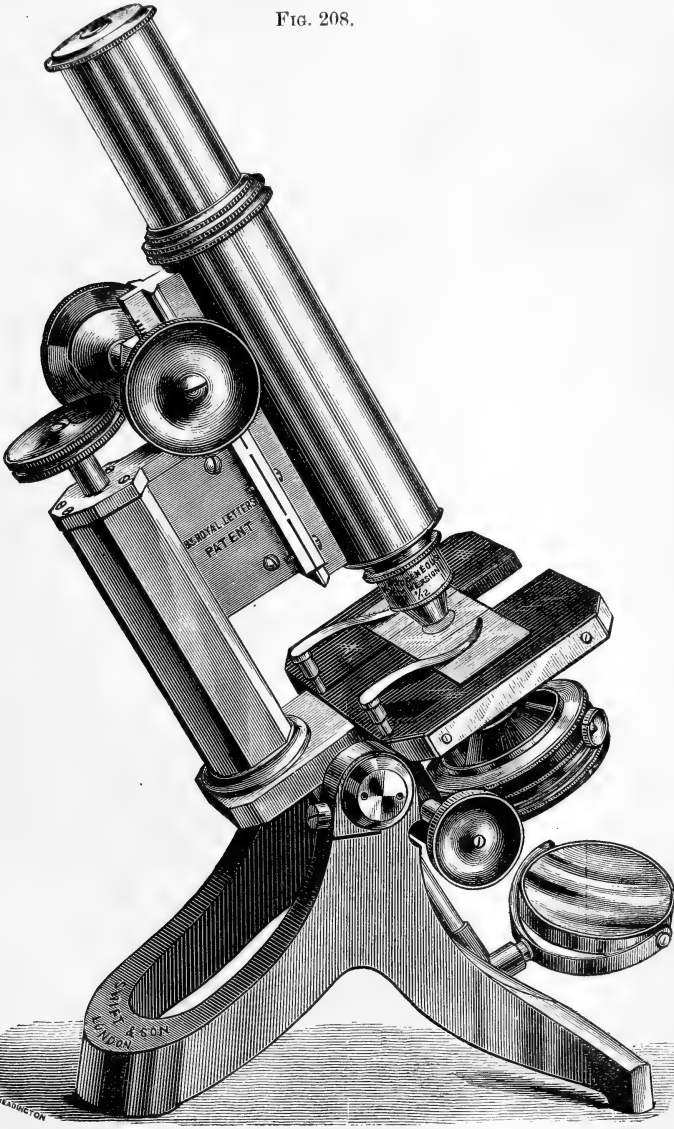
convenient for mounting purposes, as shown by Mr. Deby's Twin Microscope.* Three bodies and three objectives (by which three observers can look at three different objects at once) do not, however, afford the convenience of the former arrangement, while they make a useless addition to the latter.

The three objectives have a common focusing arrangement, no provision being made for focusing separately objectives of different powers.

* See this Journal, 1886, p. 854.

Crookshank's Bacteriological Microscope.—Messrs. Swift and Son have recently brought out this instrument (fig. 208), under the instructions of Dr. E. M. Crookshank, specially for bacteriological work.

Fig. 208.



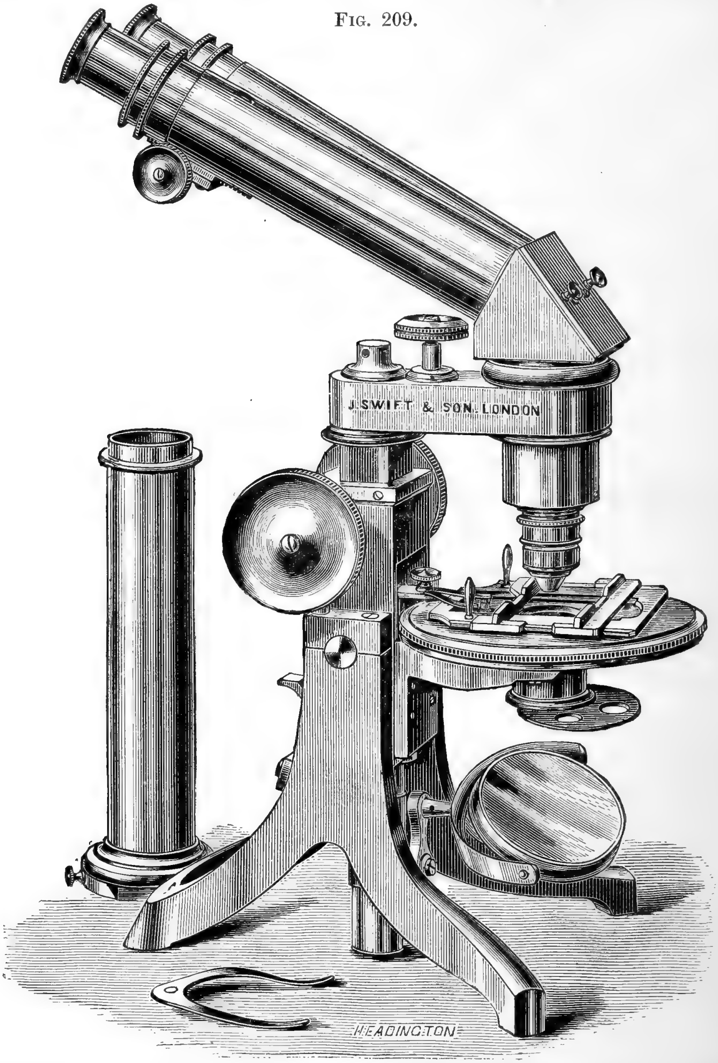
It is provided with an extra large stage with glass surface, which is slotted in the centre to facilitate focusing with high powers, and the removal of the slides. A modified form of the Abbe condenser, with high angle, is applied to the centering substage and fine crossed lines are ruled on the

upper surface of the condenser to mark the centre. The focus of the condenser is adjusted by rack-and-pinion movement.

The principal novelty, however, is in the application of a *lever* to the parallel-spring fine-adjustment of Bausch and Lomb, by which Messrs. Swift have greatly lessened the speed of the movement, at the same time reversing the action of the focusing screw.*

Stephenson's Erecting Binocular Microscope.—Mr. J. W. Stephenson's Erecting Binocular Microscope has approved itself to microscopists, and

Fig. 209.



especially to botanists, as by far the most practical and convenient form hitherto devised where high powers are to be used. Indeed, with the

* See *infra*, p. 808.

higher power objectives it has no rival, as a 1/16 in. or even 1/25 in. objective can be used binocularly with full and equal illumination in both tubes. Messrs. Swift & Son now issue it in three forms, two of which are shown in figs. 209 and 210, the third form being intermediate in size between these two.

Fig. 210.

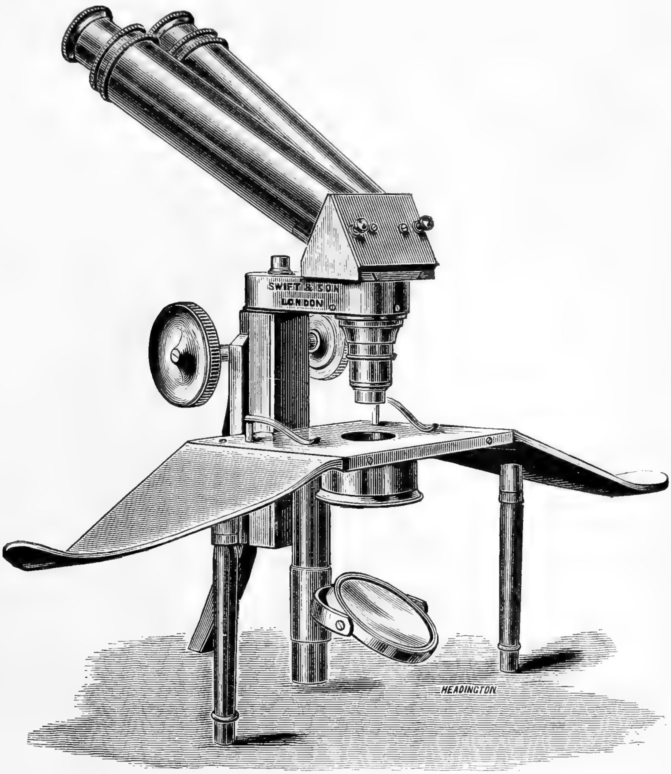


Fig. 210 shows the binocular adapted to a dissecting stand, the erection of the image being especially convenient for making dissections.

The instrument can be readily converted into a monocular when required; the monocular tube is shown in fig. 209.

Gomont's "new" Botanizing Microscope.*—We often have to comment on our German friends for reproducing as novelties microscopical accessories—notably mechanical stages—which have been in existence in this country for many years. We here have a similar case from a French source, the Microscope described as a novelty by M. M. Gomont being a very old friend. We translate the description verbatim:—

"Botanical excursions for collecting algæ and the lower fungi lose, as is well known, a part of their charm and utility in consequence of the difficulty which the botanist experiences in recognizing on the spot the species which he finds. For these small plants a simple lens, whatever may be its amplifying power, is always much too feeble, and it is absolutely

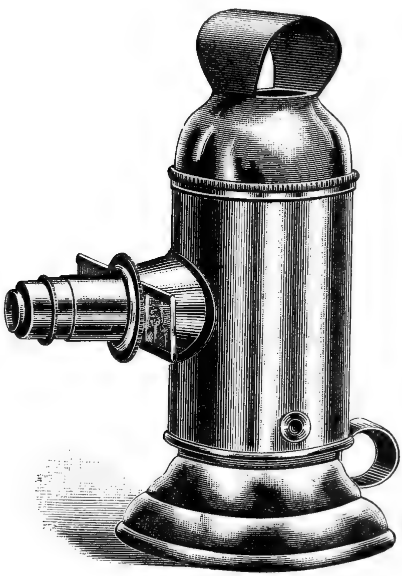
* Bull. Soc. Bot. France, xxxiv. (1887) pp. 216–7.

necessary to have recourse to a compound Microscope. I have endeavoured to modify the form and mode of illumination of this instrument whilst preserving a sufficient power to make it applicable to all cases. The arrangement which I have devised having appeared to some of my colleagues to be very practical I will give here a short description of it.

The instrument consists of an ordinary Microscope tube, sliding smoothly in another tube, which is closed at its lower or objective end by a kind of screw cover which has a small aperture in the centre, which acts as a diaphragm. At the plane of this diaphragm the tube has a slit for the introduction of a slide. A ring sliding on the tube presses on the slide and fulfils the same functions as the clips of a Microscope. The object is illuminated by directing the instrument like an opera-glass to a white cloud or any other brightly illuminated object. The light from these large natural reflectors is sufficient for a power of 250 diameters, a power which it is useless to exceed for the purpose in view, and which it will be very rarely necessary to reach. The preparation of the object to be examined is effected in the field in a very simple manner, the cover-glass adhering sufficiently to the slide to allow of all possible positions being given to the instrument. The diaphragm can be readily removed when it is necessary to alter the tube.

As will be seen, I have been obliged to give to this Microscope as simple an arrangement as possible in consequence of the accidents to which an instrument of this kind is exposed during botanizing. I hope that, notwithstanding its little complication, it will be useful to botanists who are addicted to the investigation of the lower plants, or even in a more general way, to naturalists who have taken as the object of their studies the microscopical organisms."

Fig. 211.



Rochester Magic Lantern and Projection Microscope. — Without committing ourselves to the statement of the designers (the Bausch and Lomb Optical Co.) that this, fig. 211, is "the neatest, cheapest, and best lantern ever introduced," and "without exception far superior to any other both for its size and price," it may be admitted that it is a very handy little lantern (8 in. high). It is made entirely of brass, lacquered, and is so arranged that ordinary 3×1 in. slides can be used, and the image projected on a screen.

An additional recommendation (to utilitarian Microscopists at any rate) is that the lamp "being a regular hand-lamp, makes the lantern more valuable, as the same can be used at any time about the house."

Schott's Microscopes.—On pp. 148–150 we directed attention to certain figures of Microscopes from Schott's 'Magia Universalis,' published in 1657, which had long puzzled microscopists by their apparently exceptional and extraordinary size. We submitted an explanation, namely, that

the draughtsman, knowing possibly nothing of the purposes of the instruments, instead of drawing *an eye* directed upon them, drew full-length figures, whence by comparison the Microscopes appear of enormous size. This explanation was suggested to us by certain figures of Microscopes in Traber's 'Nervus opticus,' published in 1690, which we reproduced in support of our view of the matter. We have since met with the first edition of Traber's work, published in 1675, in which the same figures were given. On comparing Traber's descriptions with those given by Schott we are strongly confirmed in our opinion that the former was referring to the same Microscopes as those described by the latter.

In support of our explanation we remark that our fig. 13 from Schott's 'Magia Universalis' does not correspond with his own *description* of it (loc. cit., p. 535), for he states that the Microscope is "super tripedale fulcrum," though the drawing shows a cylindrical tube-support without any visible means of illuminating the objects, and such as, in our opinion, was never actually constructed. Whereas Traber's figure (our fig. 16) answers fairly to Schott's description, the open tripod support being a practical form that clearly forms a link in the evolution of the mechanical designs of Microscopes.

We omitted to note that Schott assigns the construction of the instrument to Eustachio Divini thus:—"Huius modi microscopia excellentissima facit Romæ Eustachius Divini . . . ." (loc. cit.).

In further confirmation we remark that in another drawing given by Schott (our fig. 212) a candle and a lens are shown, and by comparison with the full-length figure of a man kneeling and viewing the candle through the lens the latter might be supposed 3–4 feet in diameter, quite beyond the possibility of manufacture at that date. Schott states that from Kircher's 'Ars magna lucis et umbræ' (1646) he found the lens was

Fig. 212.

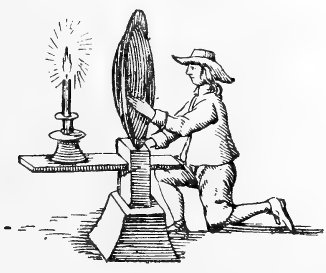
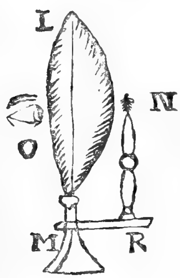


Fig. 213.

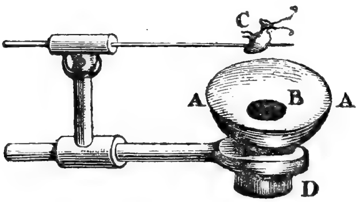


designed by Descartes to have hyperbolic surfaces. On reference to Kircher's text we find Descartes and the hyperbolic surfaces mentioned, thus identifying the instrument, but the figure illustrating the text again shows *an eye* only directed to the lens (vide fig. 213 reproduced from Kircher), whence by comparison the lens appears to be only 4–5 in. in diameter, a size that may have been reached at that date. In reproducing Kircher's woodcut Schott's draughtsman is thus clearly proved to have substituted a full-length figure of a man for the representation of the eye only of the original; the probability of his having done so likewise with other drawings is hence easy to understand and our conjecture is thus shown to have been the true explanation.

Another ludicrous feature may also be noted, viz.:—that in Kircher's figure the eye is viewing an *insect* through the lens, which Schott's draughtsman apparently mistook for a *candle-flame*, and hence substituted the latter!

Lieberkühn's Microscope.—The earliest representation we have met with of this instrument is in P. van Musschenbroek's 'Essai de Physique,'* tome ii. pl. xviii. fig. 6, and as we believe it to be hitherto practically unknown to English microscopists we reproduce it in fig. 214.

Fig. 214.

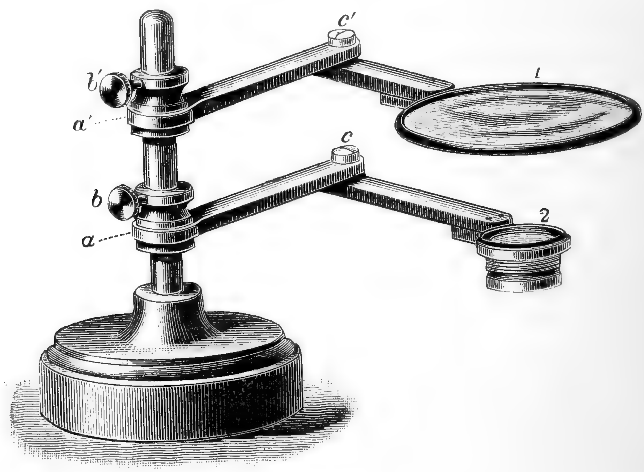


The following is a translation of Musschenbroek's description (loc. cit., p. 595) of the figure:—

"There has also been recently discovered a good way of strongly illuminating large opaque objects, so that they may be examined by every kind of Microscope, even by means of the smallest kinds. A A is a small spherical concave mirror of fine silver, well ground and polished, whence the light is reflected to a focus on the object C, so that it is strongly illuminated at the back. This mirror is pierced in the middle B, and the Microscope [lens or object-glass] is there inserted and adjusted either forward or backward: the eye is placed at D and the object is seen very clearly."

Weinzierl's Simple Microscope for the Examination of Seeds.†—This instrument (fig. 215), the invention of Dr. v. Weinzierl, consists of a solid brass stand leaded at the foot, and carrying two arms jointed at c' and c, at

Fig. 215.



the extremity of which are lenses 1 and 2. The arms move horizontally round through the bearings at a and a', and they are fixed by the screws b and b' in any desired position.

The weaker lens No. 1 is a simple biconvex lens 9 cm. in diameter, and with a focal distance of 25 cm. It has a magnifying power of $2\frac{1}{3}$ times. No. 2 is more powerful. It consists of two achromatic lenses 29 mm. in

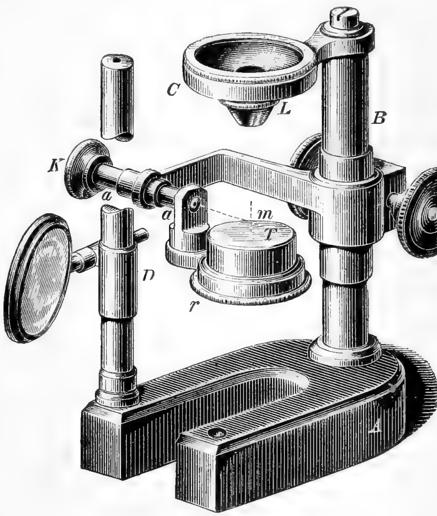
* 2 vols 4to, Leyden, 1739. † Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 42–4 (1 fig.).

diameter, and has a focal distance of 14 cm. It magnifies about 5 times. The advantages claimed for this instrument are that with No. 1 lens both eyes can be used at once, the field of vision is considerable, and both hands are left free for manipulation. If greater magnification be desired, No. 2 lens is easily put in position, or both may be employed at the same time.

Vogel's Lens-stand for Entomological purposes.*— This apparatus (fig. 216), has been for many years used by Prof. H. C. Vogel in the study of small insects.

On a horseshoe foot A is a brass pillar B, which carries a conical piece C to hold the lenses. T is the stage which is raised or lowered on the pillar B by rack and pinion, and so focused to the lens L. The lenses supplied with the apparatus are all set in conical fittings which drop into C. The important feature of the apparatus is the facility for moving the stage into any desired position. It consists of a cork T, set in a brass ring, terminating below in a milled head *r*, by which the stage is rotated in its own plane, while by the milled head K it can be rotated about a horizontal axis *a a*. This axis is also made to slide in its bearings, so that different small objects fixed in a line on T can be successively brought into the centre of the field. Thus, the object *m* when placed at a point on the prolongation of *a a*, is capable of a fourfold movement without having materially to alter the focal adjustment. D is the illuminating lens which slides along a brass pillar fixed in either of two holes upon the ends of the horseshoe foot, so that the object can be illuminated from either side. This lens may also be conveniently used in mounting large objects, for which purpose it is raised to the top of the pillar and swung round to occupy the position of C which is thrown back. For transparent objects the cork is replaced by a glass plate.

Fig. 216.



Westien's improved Universal Clamp for Lens-holders, &c.†— The clamp of Herr H. Westien, the construction of which was described in 1885,‡ has since received improvements which have not only made its production easier but have considerably widened its field of utility. This clamp renders it possible by a single screw motion to clamp securely to an upright an object provided with a bar of any form, whether round, oval, triangular, square, or flat. The upright may also vary in size from 2–9 mm., from

* Zeitschr. f. Instrumentenk., vii. (1887) pp. 173–5 (1 fig.).
† Ibid., pp. 54–5 (1 fig.).
‡ See this Journal, 1885, p. 316.

5–13 mm., or from 7–15 mm., according to the clamp used, and may also be round, oval, triangular, square, or flat in section. The construction is as follows (fig. 217).

On the pin A having a hook-shaped head, is the cup B, the clamp C, and the nut D, which is provided with a washer. D works upon a screw-thread on the pin, and when screwed up presses together the clamp C and the cup B, by which the bar H is clamped in the angle of C, while on the other side the hook draws the cup against the upright J, so that J and H are firmly clamped together by the single screw D.

Fig. 217.

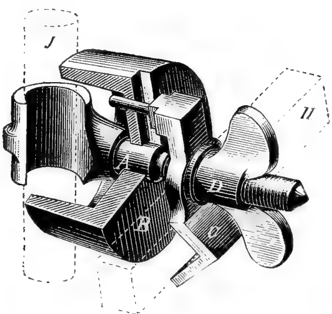
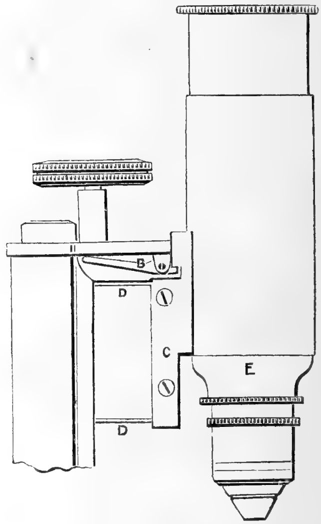


Fig. 218.



Swift's Lever and Parallel-spring Fine-adjustment. — Messrs. Swift and Son, as noted *supra*, p. 218, have applied a lever to the parallel-spring fine-adjustment of Bausch and Lomb by which the speed of the movement is much lessened. The mechanism is shown in fig. 218 (reduced from the drawing to the specification of the patent).

The milled-head screw acts upon the lever B, the short end of which engages in the piece C, which is attached to the body-tube E, and is supported at the back by the parallel springs D D connected with the stem.

The movement of the screw raises or lowers C at a very slow rate against the tension of the springs DD.

NEUMANN, C.—**Die Brillen, das dioptrische Fernrohr und Mikroskop. Handbuch für praktische Optiker.** (Spectacles, the dioptric Telescope and Microscope. Handbook for practical opticians.) 256 pp. and 60 figs., 8vo, Wien, 1887.

STEIN, S. T.—**Die Optische Projektionskunst im Dienste der exakten Wissenschaften.** (The art of optical projection in aid of the exact sciences.)
[Reprint from Part V. of 'Das Licht.' Cf. *ante*, p. 161. Contains a chapter on "the Projection of Microscopic Objects."]
viii. and 155 pp., 183 figs., 8vo, Halle a. S., 1887.

Woodhead's Microscope with large stage for the examination of sections through entire organs. *Brit. Med. Journ.*, 1887, No. 1391, p. 469.

(2) Eye-pieces and Objectives.

BURRILL, T. J.—**A new Objective.**

[Report of examination of a Zeiss 2 mm. apochromatic objective and eye-pieces. "The objective has shown itself to be of very high grade among those of modern production, but judging by results obtained it cannot reveal anything not heretofore seen under similar circumstances with the best work of at least six opticians."]

The Microscope, VII. (1887) pp. 233–7.

SCHÜLL, P.—**Ueber das Centriren optischer Linsen.** (On the centering of optical lenses.)

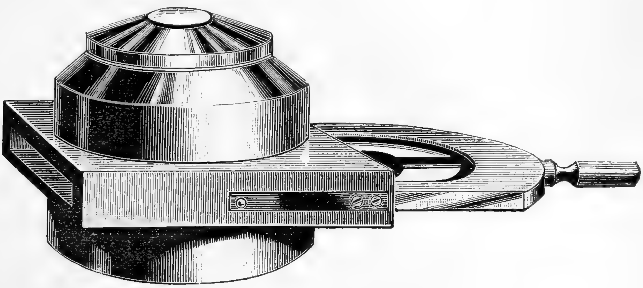
[Practical directions.]

Central-Ztg. f. Opt. u. Mech., VIII. (1887) pp 181–2, 194–6 (3 figs.).

(3) Illuminating and other Apparatus.

Bausch and Lomb Condenser and Substage.*—This (fig. 219) consists of a condenser and substage, the latter having five stops, diaphragms and blue glass. The lenses of the condenser are of such a size as to utilize almost all the rays of light which may pass through the substage ring. In order that objectives having a large aperture may be used, the condenser

FIG 219.



has been made with a numerical aperture of about 1·42 (another of 1·20 is also manufactured). Its volume of light is sufficient with the highest amplification, and although it gives an intense light at the focal point it may be distributed over a large space by varying its distance from the object. It will work both dry and immersion. The mounting of this condenser is new and simple, and is so arranged that the instrument can be used where the substage is adjustable or fixed. The diaphragms are separate.

Reichert's improved Mechanical Stage.†—Prof. E. F. v. Marxow describes an improvement of Reichert's mechanical stage which allows it to be fitted to any Microscope without requiring any alteration of the stand. In the original form it will be remembered the stage was fitted to the Microscope by passing the bar projecting from the posterior side of the stage through an aperture cut in the pillar of the Microscope, the bar having rackwork on it by which the stage was moved backwards and forwards. In the new form the pillar is not required to be pierced, but the stage is clamped to the pillar.

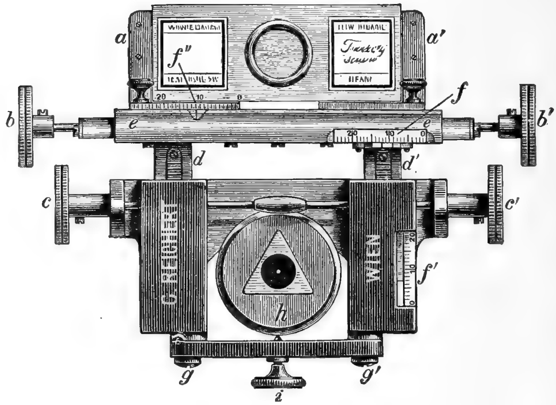
The posterior part of the stage (fig. 220) consists of two parallel bars *d d′* on the upper surface of which is rackwork. These bars are joined together by the pieces *c c′* and *g g′*, the former being hollowed out in order

* The Microscope, vii. (1887) p. 16 (1 fig.).

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 25–30 (1 fig.).

to fit against the pillar *h* of the Microscope. The piece *g g'* turns on *g'*, in order that the stage may be slipped on the Microscope, and this done, it is held in position by means of the steel-pointed screw *i*. The piece *c c'* is terminated at each end by a milled head, which, in connection with the

Fig. 220.



rackwork on *d d'*, moves the stage backwards and forwards. These two bars *d d'* are also connected with *a a'*, upon which the slide rests. Lateral movement is obtained through *e e*, which is a slotted cylinder terminated at each end by the milled heads *b b'*.

The scales *f* and *f'* enable any particular point of the preparation to be found again, but if the slide has been removed from the stage it is necessary also to note the reading of the scale *f''*.

Borden's Electrical Constant-temperature Apparatus.* — Dr. W. C. Borden describes an apparatus for maintaining a constant temperature, which will not easily get out of order, and can be depended upon to maintain the temperature desired, intended more especially for the use of those who have no gas at command, but have to use either petroleum or alcohol as a source of heat. It can be left for hours with the certainty that when again examined the heat will not have gone above a certain point or have dropped at any time more than one-half or possibly one degree below it.

The general form of the entire apparatus is shown in fig. 222, and the regulating thermometer in fig. 221. The battery used is the ordinary gravity battery used in telegraphy which gives a current of nearly constant quantity, and requires but little attention.

The regulating thermometer (fig. 221) is made by taking a small glass vial, filling the lower part with mercury and the upper with 95 per cent. alcohol, corking it tightly and passing a small glass tube through the cork at the bottom. The cork must fit very closely and should be made impervious to water by soaking in melted paraffin for several hours. The top of the tube is to be loosely corked and two wires passed down into it through the cork without touching each other—one A well down into the mercury, and the other B free above it. This regulating thermometer is now hung in the water-bath supported by the cork C, and when the temperature of the bath, as shown by a standard thermometer, has reached

* Amer. Mon. Micr. Journ., viii. (1887) pp. 131–3 (2 figs.).

the highest point desired the wire above the mercury is pushed down so as just to touch the surface of the latter. It is obvious that if the bath be filled with water below the temperature desired the mercury will not rise and touch the wire B, thus making connection with the other wire, until

FIG. 221.

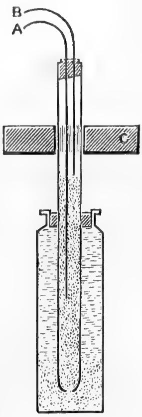
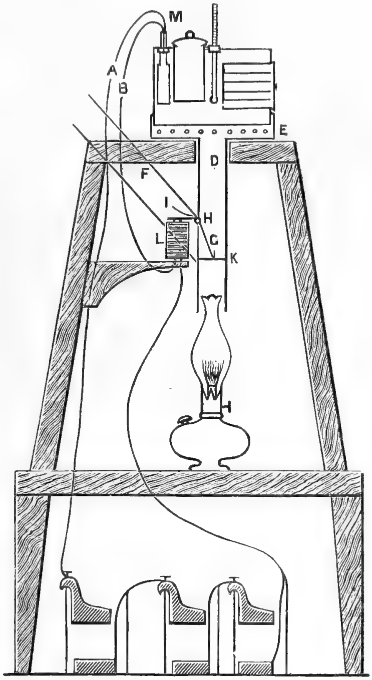


FIG. 222.



the bath reaches that temperature, and that as soon as the temperature falls below this point the mercury will fall with it and away from the wire B; also that by raising or lowering this wire the connection can be made to take place at any desired higher or lower temperature. This regulating thermometer will be found to be sufficiently delicate to keep the temperature to within two degrees. It can be made by simply blowing a bulb on a glass tube and filling the bulb and tube with mercury alone.

Fitting over the top of the lamp-chimney is a chimney D, 11 in. long and $2\frac{3}{4}$ in. square, having at its top a hot-air chamber E, into which the water-bath fits. This chamber has holes round the sides near the bottom for the escape of air. The chimney D has at one side a branch chimney F, 12 in. long, opening into it at an angle of 45°. In the opening between the chimneys is hung a valve G, turning on a hinge H, and moved by a lever I on the outside. This valve should be very light, and must turn easily on the hinge which is made by hanging the valve fastened on a wire through holes on the sides of the chimney; to this wire is attached on the outside the lever which is to be weighted on the end with a small bullet, so as nearly to balance the valve which must just fall of its own weight. At K is a shelf $2\frac{1}{4}$ in. wide extending into the chimney D. This shelf leaves an opening in the chimney 1/2 in. wide which is sufficient for

the passage upwards of the hot-air, and which can be readily closed or opened by the valve without too far swinging. At L is an electro-magnet, which is connected with one pole of the battery and with the regulating thermometer by means of the wire B. The regulating thermometer is connected with the other pole of the battery by means of the wire A.

The action of the apparatus is sufficiently plain. The lamp being lighted, the temperature of the water-bath will rise, and the mercury in the regulating thermometer M with it, until it touches the wire B, thus closing the circuit and magnetizing the electro-magnet, which will attract the lever I, pulling it down, and raising the valve G, so closing the opening in the chimney K, when the heat will escape by the branch chimney F. The temperature of the bath will now fall slightly, and the mercury with it away from B, thus breaking the circuit and demagnetizing the electro-magnet, which will cease to attract the lever, and so allow the valve to fall of its own weight, closing the opening into the branch chimney and allowing the hot air to again ascend through K and reheat the water-bath. This regulating action will continue as long as any oil remains in the lamp, which should therefore have a large reservoir and the flame be turned only high enough to keep the bath slightly above the temperature desired. "With this apparatus many processes such as Weigert's hæmatoxylin staining of the nervous system, which, without a constant temperature of long continued duration are impossible of performing, are made easy; and any one who has had the bother of watching a bath while imbedding in paraffin will appreciate the gain arising from an apparatus which will run all night and have the tissues in good condition for imbedding in the morning, to say nothing of the many other uses, besides staining and imbedding, to which it can be put."

Lighton's Analysing Diaphragm for the Polariscope.* — Mr. W. Lighton describes this apparatus as follows, stating that he has found it to be of great help in the study of crystallography.

"We will suppose that the polariscope as ordinarily used has been placed in position, the polarizing prism below the stage and the analysing prism above the objective. The apparatus consists simply of a cap with movable diaphragm placed over the eye-piece, as illustrated in figs. 223 and 224. Fig. 223 is a sectional view, and fig. 224 a top view of the cap of the eye-piece. The letters in both figs. refer to the same parts. Let AA indicate the axis of the tube; B, the eye-piece; C, the cap of the eye-piece. The apparatus consists merely in a diaphragm plate D, swinging from right to left on the pivot I. This motion is given by placing the finger at the knob L. The amount of motion is controlled by the two small studs G. The diaphragm is pierced by a small hole H, 1/8 in. in diameter. E is a screw in the top of I, holding the diaphragm in place. F is the apex of the cone of light formed by the image of the source of light passing through the eye-piece. Now, if the diaphragm be so adjusted by sliding the cap upon the eye-piece that it will be on a level with this point of light a very interesting series of optical effects will be observed. The small studs G should be so placed that when the diaphragm is swung to the right or left the sides of the hole H will just cut the axis of the eye-lens (apex of cone of light).

I will mention a few of the sights seen by its use as described above. In no case were the prisms of the polariscope revolved. A crystal of chlorate of potash was selected, which, upon simply revolving the stage, passed merely from an orange-purple to a dull grey. On introducing the cap and

* Amer. Mon. Micr. Journ., viii. (1887) pp. 109–10 (2 figs.).

passing the diaphragm from right to left a beautiful series of the most brilliant tints was seen—a fine navy blue changing to purple, orange, and then to lemon-yellow, and lastly pale straw colour. A section of fortification agate was taken which showed a small crystal of pure quartz in one portion. With the diaphragm used as before from right to left, the colour

FIG. 223.

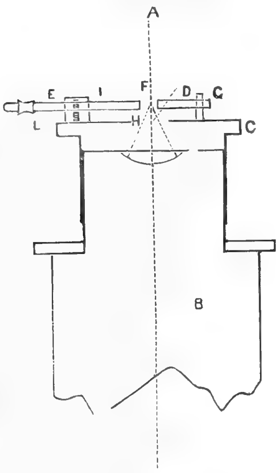
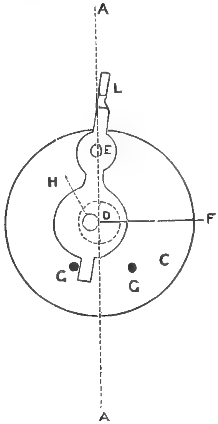


FIG. 224.



of the crystal was merged from bright-green to magenta, and then to a velvety brown-red. With the usual revolution of the stage the colours exhibited were green fading to a dull black.

With this apparatus there is not only a more varied and brilliant series of colours, but also a marked intensification of points of structure. In the two above-mentioned slides delicate lines of crystallization were shown which were invisible under ordinary circumstances.

One of the small, curiously-branched bones of the red-horse, a fish common in this region, was examined, and showed the bone-cells in a remarkably distinct way, they being quite indistinct without the diaphragm."

Auer's Incandescent Gas-burner as a Microscope Lamp.*—Dr. K. Bürkner recommends Auer's gas-lamp for use with the Microscope. He has employed it for some time and finds it very satisfactory both in power and quality. The light emitted is intense, but not blinding, and is relatively white as compared with the ordinary gas-flame or that from paraffin. Another advantage is the small amount of heat given off. The lamp is merely an ordinary Bunsen's burner, the flame of which is surrounded by a chimney or sheath impregnated with the nitrates of cerium, didymium, lanthanum, ittrium. The incandescent chimney is upheld by a platinum wire tied to a bearer which can be raised or lowered by means of a screw, and is further inclosed in a glass chimney. As the incandescent chimney consists of ash, it is necessarily somewhat susceptible of damage.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 35–8 (1 fig.).

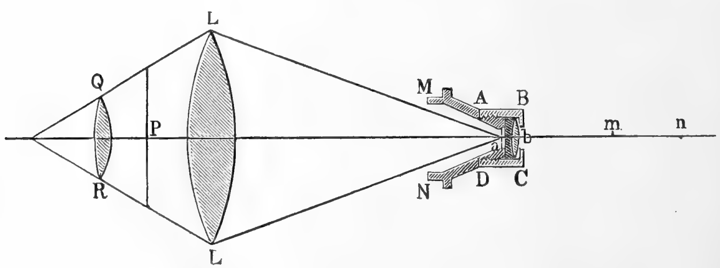
This is apparently the only inconvenience associated with the burner, and is more than compensated by the advantages of the light.

"Old and New Microscopical Instruments."—Apparatus for testing Refractive Index.*—The text of Dr. G. Martinotti's article under the above quoted title is that there is nothing new under the sun, and as here applied, he remarks how frequently the newer apparatus is but an improvement on, or a perfectioning of, some older instrument. As an example, he refers to Prof. H. L. Smith's apparatus for determining the refractive index of liquids.†

Between two plates of crown glass is formed a space, one side of which is flat, the other concave. When the cavity is filled with a liquid with higher refractive index than that of glass, a plano-convex lens is the result. By means of a simple device this artificial lens is fitted behind the weak objective of a compound Microscope, so that the two form an optical system. Then, according to the difference in the refractive index of the interposed lens, the image of the object examined falls at a different distance, and the amount of displacement imparted to the optical arrangement in order to see the object clearly gives the refractive index of the liquid under examination.

The author then remarks that the principle had been previously applied for the same purpose, but in a somewhat different manner. The reference is to Sir D. Brewster's 'Treatise on new Philosophical Instruments for various purposes in the arts and sciences,' Edinburgh, 1813. In this, at p. 240, will be found the 'Description of an instrument for measuring the refractive power of fluids. . . .' There Brewster refers to the fact that Euler had already conceived the notion of determining the refractive indices of liquids by inclosing them between two lenses (menisci). This idea was carried out, though imperfectly, by his son. Brewster's device was as follows (p. 247):—In the extremity M N of a Microscope fitted with its objective is placed a thin plate of glass *a*. The biconvex lens *b* is fixed to the end of a short tube A B C D, screwed on to M N so that the internal

FIG. 225.



surface of the lens could be made to touch the plate *a*, or removed away from it. In A B C D, just behind the lens *b*, are two holes for the introduction of fluids into the cavity between *a* and *b*. Thus is formed a plano-convex lens which can be diminished or increased in size by altering the position of the screw.

The plano-convex lens increases the focal length of *b*, and therefore forms the image of any object *m*, at a greater distance from the point P, situate at the anterior focus of the ocular Q R. But as the lenses Q R and

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 320–30 (1 fig.).
† See this Journal, 1885, p. 1066.

L L are fixed, the object must be removed to a in order to get a distinct image at the point P, and the greater the density of the fluid the longer the distance from b. Hence $b\,m$, $b\,n$ give the relative value of the refractive index of the liquid under examination, and with a little calculation the absolute value also. In his research Brewster kept the distance between the lenses invariable, and the thickness of the plano-convex lens identical, for all cases under examination. The objects used were scratches on the surface of a piece of glass. He adds an important detail which has been passed over by Smith. Across the diaphragm at the anterior focus of the ocular he stretched a very fine thread, which, as well as the mark in front of the objective, he tried to keep distinctly in view, in order to prevent any error depending on the eye of the observer.

The fundamental principle of the two instruments is alike, although, instead of a plano-convex lens of definite thickness, in the older apparatus the thickness was variable. It is more convenient, however, for the artificial lens to have constant dimensions as in Smith's apparatus, and not variable ones as in Brewster's instrument, for when the distance which it is necessary to remove the objective from the object in order to see it distinctly is known, the calculation is readily made.

A plate of glass is placed behind the objective, and the latter removed to such a distance from the object (say a micrometer) that it is seen distinctly. Let this distance be p. The cavity containing the liquid to be examined is then placed behind the objective. In order that the eye behind the ocular Q R may clearly distinguish the micrometer image at P, it becomes necessary to remove the objective to a further point p'. Let P indicate the distance at which, in both cases, the image of the micrometer is formed behind the objective; f the focal length of the biconvex lens b; f' that of the added lens; and F the focal length which results from the combination of the two lenses.

From the law of conjugate foci

$$\frac{1}{p} + \frac{1}{\mathrm{P}} = \frac{1}{f} \quad \text{and} \quad \frac{1}{p'} + \frac{1}{\mathrm{P}} = \frac{1}{\mathrm{F}}.$$

By subtraction—

$$\frac{1}{p} - \frac{1}{p'} + \frac{1}{\mathrm{P}} - \frac{1}{\mathrm{P}} = \frac{1}{f} - \frac{1}{\mathrm{F}};$$

or

$$\frac{1}{p} - \frac{1}{p'} = \frac{1}{f} - \frac{1}{\mathrm{F}'}.$$

But

$$\frac{1}{\mathrm{F}} = \frac{1}{f} - \frac{1}{f'};$$

and on substituting this value in the previous equation we have

$$\frac{1}{p} = \frac{1}{p'} = \frac{1}{f} - \frac{1}{f} + \frac{1}{f'} = \frac{1}{f'}.$$

Next let n be the index of refraction of the artificial lens, and r its radius of curvature: then as

$$\frac{1}{f} = \frac{n-1}{r},$$

we have

$$\frac{1}{p} - \frac{1}{p'} = \frac{n-1}{r}.$$

If the value of r be accurately known, it becomes easy to find the value of n:

$$n - 1 = r\left(\frac{1}{p} - \frac{1}{p'}\right)$$

$$n = 1 + r\left(\frac{1}{p} - \frac{1}{p'}\right) \quad . \quad . \quad . \quad a.$$

But as in practice it is difficult to determine the exact value of r, it is better to find, not the absolute refractive index of the liquid, but that relative to a substance the refractive power of which is already known, for example, glass or water.

Let n' be the index of refraction of the comparing substance, and p'' the distance to which in this case the objective is moved from the micrometer; the formula then becomes

$$\frac{1}{p} - \frac{1}{p''} = \frac{n' - 1}{r},$$

from which

$$r = \frac{n' - 1}{\frac{1}{p} - \frac{1}{p''}} = (n' - 1)\left(\frac{1}{\frac{1}{p} - \frac{1}{p''}}\right).$$

By substituting the value of r in the equation a we get

$$n = 1 + (n' - 1)\left(\frac{1}{\frac{1}{p} - \frac{1}{p''}}\right)\left(\frac{1}{p} - \frac{1}{p'}\right),$$

or

$$n = 1 + (n' - 1)\frac{\left(\frac{1}{p} - \frac{1}{p'}\right)}{\left(\frac{1}{p} - \frac{1}{p''}\right)}.$$

But

$$\frac{\frac{1}{p} - \frac{1}{p'}}{\frac{1}{p} - \frac{1}{p''}} = \frac{\frac{p' - p}{pp'}}{\frac{p'' - p}{pp''}} = \frac{p''(p' - p)}{p'(p'' - p)} = \frac{p''}{p'}\frac{p' - p}{p'' - p} = \frac{p''p(p' - p)}{p'p(p'' - p')},$$

and the equation becomes

$$n = 1 + \frac{p''}{p'}\frac{p' - p}{p'' - p}(n' - 1) \; . \; . \; . \; \beta.$$

Where the value of n', that is the refractive index of the liquid used for comparison, is known, and the other values, that is, the distances between the objective and the object, it becomes sufficiently easy to make the required calculation.

Instead of measuring these distances, it is possible and more convenient to calculate them. In the three cases before us let us suppose these to be $g\ g'\ g''$: then when the optical arrangement remains the same, there is a constant relation between these and the focal length of

$$g\,p = g\,p' = g''\,p'' \; . \; . \; . \; \gamma.$$

In the equation β the values of $p\ p'\ p''$ may be expressed in functions of $g\ g'\ g''$ taken from equation γ.

Then

$$p'' = \frac{g\,p}{g''}\;p' = \frac{p\,g}{g'},$$

and

$$\frac{p''}{p'} = \frac{\dfrac{g\,p}{g''}}{\dfrac{g\,p}{g'}} = \frac{g'}{g''}.$$

Again,

$$p' - p = \frac{g\,p}{g} - p = p\left(\frac{g}{g'} - 1\right),$$

and

$$p'' - p = \frac{g\,p}{g''} - p = p\left(\frac{g}{g''} - 1\right).$$

By substituting in equation β these values,

$$n = 1 + \frac{g'}{g''}\,\frac{p\left(\dfrac{g}{g'} - 1\right)}{p\left(\dfrac{g}{g''} - 1\right)}(n' - 1),$$

or

$$n = 1 + \frac{g'}{g''}\,\frac{\dfrac{g}{g'} - 1}{\dfrac{g}{g''} - 1}\,(n' - 1),$$

from which

$$n = 1 + \frac{g'\left(\dfrac{g}{g'} - 1\right)}{g''\left(\dfrac{g}{g''} - 1\right)}(n' - 1),$$

and lastly,

$$n = 1 + \frac{g - g'}{g - g''}\,(n' - 1).$$

This calculation is for Brewster's instrument, in which the artificial lens is plano-concave. In Smith's apparatus, in which the lens is plano-convex, the fraction $\frac{1}{f'}$ changes sign, so that $\frac{1}{\mathrm{F}} = \frac{1}{f} + \frac{1}{f'}$.

In the two equations which express the law of conjugate foci,

$$\frac{1}{p'} + \frac{1}{\mathrm{P}} = \frac{1}{\mathrm{F}},\quad \frac{1}{p} + \frac{1}{\mathrm{P}} = \frac{1}{f}$$

by subtraction

$$\frac{1}{p'} + \frac{1}{\mathrm{P}} - \frac{1}{p} - \frac{1}{\mathrm{P}} = \frac{1}{\mathrm{F}} - \frac{1}{f}$$

$$\frac{1}{p'} - \frac{1}{p} = \frac{1}{\mathrm{F}} - \frac{1}{f}.$$

Substituting for $\frac{1}{f}$ its value we get

$$\frac{1}{p'} - \frac{1}{p} = \frac{1}{f} + \frac{1}{f'} - \frac{1}{f} = \frac{1}{f'}.$$

Now

$$\frac{1}{f'} = \frac{n-1}{r};$$

then

$$\frac{1}{p'} - \frac{1}{p} = \frac{n-1}{r};$$

from which

$$n - 1 = r\left(\frac{1}{p'} - \frac{1}{p}\right)$$

$$n = 1 + r\left(\frac{1}{p'} - \frac{1}{p}\right) \ldots . \alpha.$$

With the liquid used for comparison the equation becomes

$$\frac{1}{p''} - \frac{1}{p} = \frac{n'-1}{r},$$

whence

$$r = n' - 1 \frac{1}{\frac{1}{p''} - \frac{1}{p}}.$$

By substituting the value of r in the equation α we get

$$n = 1 + (n' - 1)\left(\frac{1}{\frac{1}{p''} - \frac{1}{p}}\right)\left(\frac{1}{p'} - \frac{1}{p}\right)$$

$$n = 1 + (n' - 1)\frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{p} - \frac{1}{p}}.$$

But

$$\frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{p''} - \frac{1}{p}} = \frac{\frac{p - p'}{p'\,p}}{\frac{p - p''}{p''\,p}} = \frac{p''\,p\,(p - p')}{p\,p'\,(p - p'')} = \frac{p''\,(p - p')}{p'\,(p - p'')} = \frac{p''}{p}\,\frac{p - p'}{p - p''}$$

then

$$n = 1 + (n' - 1)\frac{p''}{p'}\,\frac{p - p'}{p - p''} \ldots \beta'.$$

By substituting for $p\,p'\,p''$ their values in functions of $g\,g'\,g''$, and remembering that

$$g\,p = g'\,p' = g''\,p'',$$

and that consequently

$$p'' = \frac{p\,g}{g''}\;p' = \frac{g\,p}{g'},$$

we get

$$\frac{p''}{p} = \frac{\frac{g\,p}{g''}}{\frac{g\,p}{g'}} = \frac{g'}{g''}.$$

Furthermore,

$$p - p' = p - \frac{g\,p}{g'} = p\left(1 - \frac{g}{g'}\right)$$

$$p - p'' = p - \frac{g\,p}{g''} = p\left(1 - \frac{g}{g''}\right).$$

By substituting these values in the equation β' we get

$$n = 1 + (n' - 1)\,\frac{g'}{g''}\,\frac{p\left(1 - \frac{g}{g'}\right)}{p\left(1 - \frac{g}{g''}\right)}$$

$$n = 1 + (n' - 1)\,\frac{g\left(1 - \frac{g}{g'}\right)}{g''\left(1 - \frac{g}{g''}\right)}$$

$$n = 1 + (n - 1)\,\frac{g' - g}{g'' - g}.$$

In conclusion, it only remains to be said that these formulæ do not take into account certain values which, if absolute precision were required, ought to come into the calculation (distance of the objective from the artificial lens, radius of curvature of the latter, &c.). Hence these formulæ give only an approximate result, but one which is sufficient for ordinary and practical purposes.

Dr. Martinotti might we think have found many better instances to illustrate his text as to the want of novelty in sub-solar matters, as Prof. Smith's apparatus is certainly a very useful device, and one for which he is entitled to all the credit of independent invention.

DAVIS, T. S.—**New Stage Accessory.**
[Consisting of a slip of glass, from the surface of which a brass pin projects at each end. Over these pins another piece of glass, with corresponding holes drilled in it, slides, and thus objects requiring to be flattened may be conveniently secured for observation.]
16th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club, 1887, p. 12.

Fasoldt's (C.) Eye-piece Micrometer.
["The lines are said to be ground in the glass, not ruled."]
Journ. New York Micr. Soc., III. (1887) p. 40.

Rogers' (W. A.) Stage Micrometer.
[In squares upon speculum metal—parts of an inch and millimetre.]
Journ. New York Micr. Soc., III. (1887) p. 40.

WINKEL, R.—**Apparat zum Markiren mikroskopischer Objekttheile.** (Apparatus for marking parts of microscopic objects.)
[Same as that described, *ante*, p. 468.]
German Patent, Kl. 42, No. 38858, 15th Sept., 1886 (1 fig.).

(4) Photomicrography.

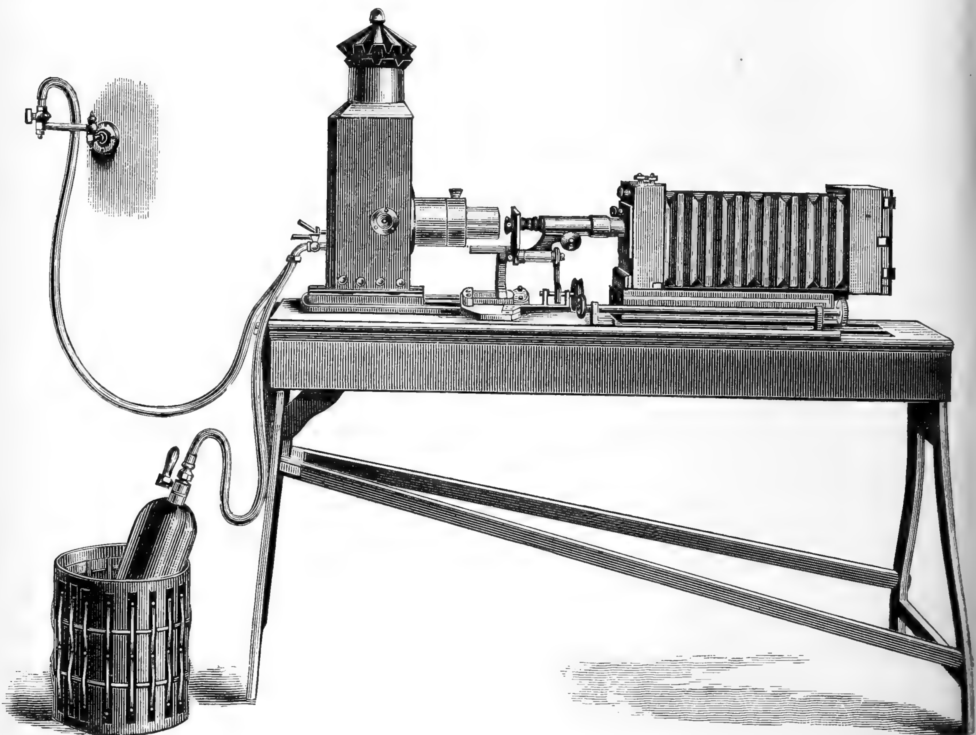
Crookshank's Reversible Photo-micrographic Apparatus.*—Dr. E. M. Crookshank's apparatus (fig. 226) consists of a camera fixed upon a baseboard 4 or 5 feet in length, upon which the Microscope is clamped, and

* Journ. and Trans. Photographic Soc. of Great Britain, xi. (1887) pp. 144–52 (1 fig.). See also Crookshank's 'Photography of Bacteria,' 1887, p. 22.

which carries also an oxyhydrogen lantern. In order to photograph micro-organisms in liquids or the colony growths in gelatin which has been partially liquefied, the apparatus can be placed in the vertical position so that the stage is horizontal.

To place the apparatus in the vertical position, two small hinged brackets at the end, distant from the camera, are forced up with a smart blow of the hand. The corresponding ends of the stretcher bars are dislodged from their fittings, and allowed to descend; when horizontal, the opposite extremities of the bars are easily released from their sockets. The leg or support at this end can then be turned up and fixed underneath

Fig. 226.



the apparatus by a button, and the end of the apparatus itself gently lowered to the ground. A hinged end-piece is also to be turned out to increase the base upon which the whole apparatus will stand when raised to the vertical. The two-legged support at the opposite end of the apparatus is next worked down by a quick thread screw, and, on raising the apparatus to the vertical, the two-legged support drops to the ground, and assists in maintaining the stability of the whole. If it be thought necessary, a simple means can be readily devised for clamping the apparatus in either position to the wall of the room, so as to eliminate as much as possible all chances of vibration. A second quick thread screw moves the base-board upon which the camera

and central sliding-board are mounted, so that the camera, Microscope, and lantern can be raised to a convenient height above the ground.

The various parts of the apparatus are described more in detail as follows:—The Microscope utilized was one constructed by Zeiss, but any good stand may be adapted in the same way. The advantage of Zeiss's stand, for bacteriological photography, is that the wide stage forms a steady support for cultivations on small panes of glass coated with nutrient jelly. A mechanical stage greatly facilitates manipulation with the highest powers; but it is not indispensable, for Dr. Crookshank has taken, without the use of one, a large number of photographs, though employing, as a rule, a 1/25 hom. imm. It is most essential that the Microscope should be perfectly steady. To ensure this the horseshoe foot-piece of the Zeiss stand fits under a projecting ledge, and is then clamped by a cross-piece, so that it is firmly fixed.

The Microscope, with the means for clamping it, and the oxyhydrogen lantern are carried upon an independent sliding-board, which admits of movement to or from the camera. The sliding-board also moves upon a centre, which enables the Microscope to be turned out from the median line; in fact, to be turned at a right angle to the position it occupies when ready for the exposure. The object of this contrivance is to enable the operator to sit down by the side of the apparatus, and with comfort to arrange the object in the field of the Microscope. On turning the Microscope back into the median line, it is fixed in the optical axis of the apparatus by means of a stop. The sliding-board was originally provided with a small grooved wheel receiving an endless cord, made of silk or fishing-line, which passed round the grooved, milled head of the fine adjustment. When the sliding-board was returned to the median line of the apparatus, the milled wheel connected with the fine-adjustment impinged upon the wheel of the long focusing rod. The latter was provided with an indiarubber tyre, which gripped the teeth of the milled wheel, and thus the long focusing rod was placed in connection with the fine-adjustment. Dr. Crookshank now dispenses with this arrangement, as he believes it to be a mistake to strain the objective by having the screen at a greater distance from the object than, say, 30 inches, and with that distance of screen one can easily move the fine-adjustment with one hand, while holding the focusing glass in the other.

Of equal importance to the objective is the sub-stage condenser, and this, for the best results, must be provided with arrangements for focusing and accurate centering.

For illumination the author has chiefly employed the oxyhydrogen light, which can be used without the interposition of a mirror in either position of the apparatus. In the horizontal position a paraffin lamp may be employed by simply removing the lantern and substituting the one for the other; but to employ this illumination when the apparatus is vertical would obviously entail another arrangement. It would in this case be necessary to adjust the mirror of the Microscope and to place the lamp in such a position that the light would be reflected in the ordinary way.

If the paraffin lamp be preferred, it should be provided with a large broad wick and a metal chimney. The burner may be made to revolve, so that either the edge or the flat of the flame may be utilized. The metal chimney has an aperture in front, giving exit to the rays of light, which is closed in by a slip of glass. The glass is very liable to crack when exposed to the full force of the flame, and it is as well, therefore, to be provided with a stock of glass slips, which have been annealed by being enveloped in a cloth and boiled for two or three hours.

Dr. Crookshank has, so far, been so satisfied with the oxyhydrogen light, both for taking direct pictures and enlarging, that he has not deemed it worth while to substitute any other. He more frequently employs it than the paraffin lamp, partly on account of the diminished time in exposure, especially when employing very high powers; this is of great importance where there is likely to be vibration from passing traffic. With rapid plates and the highest powers, the exposure has only been two or three seconds, whereas, with the paraffin lamp, it may vary from three to ten minutes, or even longer.

The illuminating apparatus here shown consists of a lantern which not only moves together with the Microscope on the central sliding-board, but can be moved independently to or from the Microscope, and be clamped with screws at the requisite distance for obtaining the best illumination. The lime cylinders should be of the best quality, of hard lime. Oxygen should be supplied preferably in a compressed state in iron bottles. Not only are the bottles much less cumbrous than the bags, but a small quantity of gas can be used, and the residue left for an indefinite time, and is always at hand to be turned on when required. On the other hand, the retention of unused gas in the bags is liable to cause their corrosion, owing to the impurities which are carried over in the manufacture of the oxygen.

A half-plate camera is employed, which is mounted upon a sliding platform. This admits of the camera being pushed up to the Microscope when it is in the long axis of the apparatus, so as to make a light-tight combination. The opening occupied in an ordinary camera by the lens, can be shut off by means of an internal shutter, which is opened and closed by turning a screw at the side of the camera. The dark-back is provided with plate-carriers, so that either half, quarter, or lantern-size plates can be employed. It is found convenient to have two or more dark-backs, so that several plates may be exposed without re-arranging the light for each exposure.

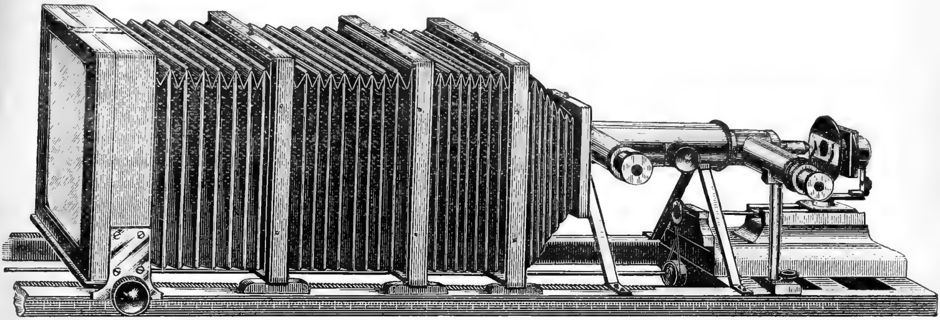
Rafter's "Professional Photo-Micro-Camera."*—Mr. G. W. Rafter criticizes a statement of the Hon. J. D. Cox that he obtained the best results in photomicrography by using a No. 1 eye-piece in the Microscope and no other amplifier. In his view the use of an eye-piece causes not only great loss of light, but also great loss of distinctness in the image. He also condemns the use of the Zeiss projection eye-pieces, on the ground that "any process that necessitates the removal of one piece of apparatus and the substitution of another in its place is for high-power work fundamentally defective," the inevitable disturbance of apparatus in making such changes leading not only to loss of time, but usually to deterioration of the negative. The author considers that the use of the simpler optical combination of the adjustable achromatic amplifier for correcting microscopic objectives when they are required to be used for projection is on the whole preferable, and hence he included in a new camera which he recently devised an arrangement for adjusting the amplifier so that the best correction of the objective can be readily obtained. After a very full exposition of the optical principles involved, the camera is described as follows:—

"In order to get such ready means of adjusting the amplifier and to

* Rafter, G. W., 'On the use of the Amplifier, With observations on the Theory and Practice of Photomicrography, suggested by the design of a new Photo-micro-camera,' sep. repr. from Rochester (N. Y.) Odontographic Journal, viii. (1887) pp. 110–44 (14 figs.).

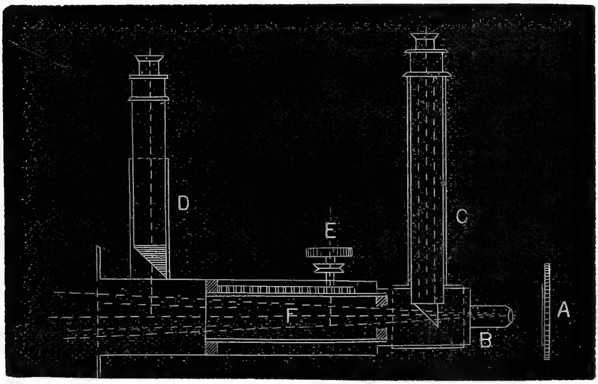
develope a photo-micro-camera which would answer all the demands which might be made upon it I have designed the apparatus shown in fig. 227. This is really a photo-micro-camera complete within itself, and not a Microscope and camera combined. I found early in my experience as a photomicrographer that one instrument could not be made to do the work

FIG. 227.



of two, and that it was only possible to use photography as a real aid to microscopical investigation by having photomicrographic apparatus which in addition to being always ready, also possessed the quality of easy adjustment to any and all kinds of work. The present design possesses not only all these qualities, but it can also be furnished at a price quite

FIG. 228.



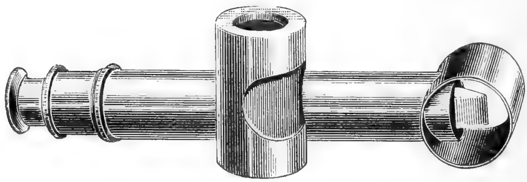
within the reach of any person really desiring such an aid to scientific investigation.

A reference to fig. 228 in conjunction with fig. 227 will show the novel points.

A in fig. 228 is the stage, B is a nose-piece which carries the objective

and also a removable collar carrying the tube C, which is supported by a removable pillar shown in fig. 227. Inside the tube C is a second tube made to work back and forth very easily, and carrying at its lower end a right-angle prism set for total reflection. This tube is of such a length as to give, when in position for receiving the image from the objective through the prism, a length of 10 in. measured along the optical axis. The eye-piece in the outer end has cross-hairs set in the diaphragm, so adjusted in relation to the prism at the other end as to correspond with cross lines on the ground glass of the camera screen. The tube C, therefore, gives

FIG. 229.



the opportunity to examine the object under the conditions of microscopic vision, and with the cross-hairs in the eye-piece farther enables the operator to exactly centre the object on the screen.

F is an adjustable tube carrying within it a second tube, which may be slid back and forth. This interior sliding tube has an adapter at the front end, into which an amplifier may be screwed, and the whole racked back and forth by the pinion E, which also carries between the thumb-screw and the body a pulley over which a band can be passed for working the amplifier from the rear of the camera screen.

This inner tube also has a graduation on the side, in order to facilitate recording the proper position of the amplifier for various extensions of the screen.

In working with high powers where it is desirable to use the amplifier, the objective is set to normal working distance by observing the object through the tube C. The operator then, from the rear of the camera, by use of the band over the pulley at E, racks the amplifier to such a position as to give a sharp and distinct image on the ground glass, the objective in the meantime remaining undisturbed. It is of course understood that after having adjusted the objective to normal working distance the inner tube at C, carrying the prism and eye-piece, has been sufficiently withdrawn to allow the rays of light to pass unobstructed to the camera screen. This gives us almost instantly the conditions which have been shown above to be necessary for production of the highest results, and with this apparatus the most difficult tests are easily photographed.

When working with low powers the amplifier is not essential for the production of sharp images, and the tube C and nose-piece B are removed by simply slipping off the collar from the nose-piece, and unscrewing the nose-piece from the body, an operation which may be performed in a moment. Fig. 229 shows these parts when detached.

After removing B and C, the inner tube F is drawn forward so that the front end of it occupies approximately the position of B when in place, and the objective is screwed into the adapter in the end of said tube F, which in high-power work carries the amplifier.

D is a second tube back of F, with prism and eye-piece with cross-wires, precisely as in C. With this tube the object is examined and centered on the ground glass, as above described, for work with C. After such centering

the focusing is completed either by use of the band passing over the pulley at E, or by use of the long rod and fine-adjustment to be described below. The inner tube at D is shown as drawn back in such position as to allow the rays of light to pass unobstructed to the screen.

The camera itself has both bellows and base made in sections, each two feet in length. The sections of the bellows can be readily removed, or additional sections inserted, when greater extension is required. . . .

The plate and screen-holder is racked back and forth as clearly shown in fig.

On the side of the base is a graduation in feet, tenths and hundredths of a foot, which enables one to record positions of the screen for producing given magnifications easily.

The fine motion is communicated to the stage, and not to the objective, as is shown in fig. 227.

The camera, as shown in the fig., admits of an extension of 8 feet, and sections of base and bellows similar to those above described can be added, extending it almost indefinitely. The extension above given will, however, answer all ordinary demands.

In its present form the camera takes a $6\frac{1}{2} \times 8\frac{1}{2}$ plate, and all sizes less than that down to the smallest.

This apparatus has been specially designed with reference to doing photomicrographic work of a high character with the greatest possible economy of time. It is for this purpose that the second prism-tube has been added specially for low-power work without the amplifier, and I have no difficulty in making with this camera a half dozen negatives in an evening, when working with lamplight and the amplifier, or from eight to ten in the same time when working with low powers and without the amplifier, in each case doing my own developing. In working by sunlight, where much shorter exposures are required, the same length of time gives an additional amount of work.

In case one has an extra Microscope, the new apparatus for working the amplifier may be adapted to it at moderate expense, and, by construction of the bellows and extension arrangements as above described, the more important advantages of the camera gained.

I desire, however, to put myself on record as opposed to the combination instruments—those which are to be used for microscopy ordinarily, but which can be, when one has something worth photographing, for the time being transformed into a camera. The trouble with all such instruments is, they have in general failed to do satisfactory photomicrographic work.

For rapid work the camera should be placed on a shelf on one side of the room at such a height as to bring the horizontal prism-tubes level with the operator's eye. The position of the camera at one side of the room insures economy of space, and does away with the objection that the camera, even though of considerable size, takes up much room.

When it is intended to work by lamplight only it will not matter which side of the room is used for this purpose, and the operator may locate the camera to suit his surroundings ; care must be taken, however, to have the graduation of the base on the side away from the wall. If one has plenty of room, the best arrangement would of course be to erect a shelf on horses in the middle of the room, so that the camera is accessible on both sides.

When it is intended to work by sunlight the camera must of necessity be at either the east or west side of a room with an exposure to the south, or when economy of space is of no importance, it can be conveniently placed in front of a window facing the south, in which may be fitted up the necessary arrangements for heliostat, mirrors, or condensing lens.

In any case, the surroundings will decide to some extent just what arrangement will be adopted.

The following are, so far as I know, the new features embodied in this camera:—

(1) The application of specific appliances for moving the amplifier back and forth, in order to find by trial, for any given extension of the camera, the best position of the amplifier for projecting the image upon the screen.

(2) The application of two horizontal prism-tubes, one for use with high powers and the amplifier, and the other for use with low powers without the amplifier.

(3) The detachable nose-piece and prism-tube for high powers only (fig. 228).

(4) The cross wires in the diaphragm of the eye-piece of the prism-tube, giving an immediate centering of the object on the camera screen.

(5) The making of the bellows in sections in such manner as to admit of their easy removal or of a ready indefinite extension.

(6) The making of the base in sections in combination with the focusing-rod, connected by an automatic coupling.

(7) The plate-holder, which admits of all sizes of plates, from the maximum of $6\frac{1}{2} \times 8\frac{1}{2}$ to the smallest, without the use of kits.

Another new feature, which, however, is not specifically claimed, is this: If one has a prejudice in favour of photographing with an eye-piece, or if, from motives of economy, one desires to dispense with the amplifier and work with the eye-piece, this may be done by simply inserting an eye-piece in the back end of the amplifier-tube. For so working, an adjustable nose-piece for carrying the objective without the high power prism-tube may be furnished, thus dispensing with one of the prism-tubes, which, however, can be added at any time by change of nose-pieces. The object can be still centered by the posterior prism-tube, which is permanently fixed to the body, and the projection of a sharp image upon the screen completed by moving the eye-piece with the pinion E (fig. 228).

The general claim is made, therefore, that this camera embodies more nearly all the conditions necessary for rapid and successful work than anything heretofore produced. I have no doubt, however, but that a very considerable improvement can still be made, and confidently expect, in view of the great interest now centering in photomicrographic work, that the next few years will develope such improvements."

It should be added that the author is not unmindful of his obligations to the photomicrographic Microscope of Nachet,* as he says, "The novel point of this camera is the use of the prism-tube somewhat as I have arranged it in my camera, and I very willingly acknowledge my indebtedness to M. Nachet for the suggestion. He has, however, used the tube vertical, and as a fixed part of the apparatus."

Hartnack's Cupro-ammonia Cell.†—Dr. E. Hartnack has ingeniously modified the form of this cell, so as to enable a thicker or thinner stratum of the blue fluid to be used at pleasure in photomicrography, thus varying the illumination according to the requirements of the particular object.

The apparatus consists of two ebonite rings, each closed on one side by a parallel plate of glass. The rings slide in one another (hermetically), and when pushed together part of the liquid is forced into a lateral reservoir, from which it is drawn again when the rings are separated.

* See this Journal, 1886, p. 840.

† Journ. de Microgr., ix. (1885) p 366.

Cox, C. F.—**Remarks on Photomicrography.**
[Principally as to letting the negatives alone after they are taken.]
Journ. New York. Micr. Soc., 1887, pp. 18–9.

H., G. M.—**A simple Photographic and Photomicrographic Apparatus.**
Engl. Mech., XLV. (1887) p. 503 (12 figs.), from *Scientific American.*

King, Y. M.—**The Photomicrography of Histological Subjects.**
New York Med. Journ., II. (1887) pp. 7–11.

Photo-Microscopy. I., II. *Charterhouse Phot. Art. Journ.*, I. (1887) pp. 2–4.

Roux, E.—**La Photographie appliquée à l'étude des microbes.** (Photography applied to the study of microbes.) *Ann. de l'Institut Pasteur*, 1887, pp. 209–25.

(5) Microscopical Optics and Manipulation.

Limit of Visibility.—In his Presidential Address at the Manchester Meeting of the British Association, Sir H. Roscoe appears to have fallen into a not unimportant mistake with regard to the smallest dimensions which can be distinguished by the Microscope.

In dealing with atoms he said:—

"Next let us ask what light the research of the last fifty years has thrown on the Daltonian atoms: first, as regards their size; secondly, in respect to their indivisibility and mutual relationships; and, thirdly, as regards their motions.

As regards the size and shape of the atoms, Dalton offered no opinion, for he had no experimental grounds on which to form it, believing that they were inconceivably small and altogether beyond the grasp of our senses aided by the most powerful appliances of art. . . .

But modern research has accomplished, as regards the size of the atom, at any rate to a certain extent, what Dalton regarded as impossible. Thus, in 1865, Loschmidt, of Vienna, came to the conclusion that the diameter of an atom of oxygen or nitrogen was 1/10,000,000 part of a centimetre. *With the highest known magnifying power we can distinguish the* 1/40,000 *part of a centimetre;* if now we imagine a cubic box each of whose sides has the above length, such a box when filled with air will contain from 60 to 100 millions of atoms of oxygen and nitrogen. A few years later William Thomson extended the methods of atomic measurement, and came to the conclusion that the distance between the centres of contiguous molecules is less than 1/5,000,000 and greater than 1/1000,000,000 of a centimetre; or, to put it in language more suited to the ordinary mind, Thomson asks us to imagine a drop of water magnified up to the size of the earth, and tells us that the coarseness of the graining of such a mass would be something between a heap of small shot and a heap of cricket-balls. Or, again, to take Clifford's illustration, you know that our best Microscopes magnify from 6000–8000 times; a Microscope which would magnify that result as much again would show the molecular structure of water. Or again, to put it in another form, if we suppose that the minutest organism we can now see were provided with equally powerful Microscopes, these beings would be able to see the atoms."*

Microscopists will readily recognize that the 1/40,000 of a centimetre —which is approximately 1/100,000 of an inch—is vastly too low a figure, which should be at least 5 times smaller. Dr. Royston-Pigott claims to have seen the 1/1,000,000 of an inch, but, whether he has or not, it is certain that the 1/500,000 of an inch has been distinctly recognized. Moreover, Sir Henry himself, as will be seen, states that a power of 8000 times is attainable "with our best Microscopes"; multiply 1/100,000 in.

* Cf. Nature, xxxvi. (1887) p. 417.

by 8000, and we get nearly 1/12 in., which it is obviously absurd to put as the limit of visibility in the microscopic image.

The difference does not affect Sir H. Roscoe's argument, for the capacity to see even the 1/1,000,000 of an inch would still leave us far from the point when atoms would be visible, but we call attention to his statement because, coming from so high an authority as a President of the British Association, it may give rise to a serious misapprehension as to the powers of the Microscope of the present day.

Heath's 'Geometrical Optics.'*—Measure of the Aperture of the Microscope.—Dr. R. S. Heath's book is, we believe, the first English treatise on optics in which aperture is dealt with. The following is the author's treatment of the subject:—

It has been shown that the brightness of an image given by a Microscope is determined by the formula

$$I = I_o \frac{\lambda^2}{p^2} \cdot \frac{u^2 \sin^2 \alpha}{m^2},$$

where λ is the conventional image distance, p the radius of the pupil of the eye, m the magnifying power, and α the divergence of the cone of rays proceeding from the object in a medium whose refractive index is u. Thus for an instrument of given magnifying power,

$$I \propto (u \sin \alpha)^2,$$

and accordingly, $u \sin \alpha$ may be taken to be the numerical measure of the aperture.

This measure of the aperture may be expressed in terms of the focal length of the objective, and diameter of the pencil passing through it. The diameter of the pencil as it passes through the object varies from the first to the last surface. We shall suppose that the diameter is taken at the back surface of the objective as the pencil emerges from it. This will be so close to the second principal focus of the objective in microscopic objectives of the ordinary type of construction, that the difference in the distance may be disregarded. We shall therefore suppose that b is the semi-diameter of the pencil at the second focal plane of the objective, and that f is the focal length of the objective. Let u' be the distance of the image from the second principal focus; then, using the ordinary notation,

$$\frac{\beta'}{\beta} = -\frac{u'}{f}.$$

Also by Helmholtz's theorem, we have

$$u \beta \sin \alpha = u' \beta' \sin \alpha',$$

and therefore

$$u \sin \alpha = u' \frac{\beta'}{\beta} \sin \alpha'$$

$$= -\frac{u'}{f} u' \sin \alpha'.$$

The angle α' is always very small in Microscopes, never exceeding a few degrees, and therefore $u' \sin \alpha'$ will not differ sensibly from $u' \tan \alpha'$. But $b = -u' \tan \alpha'$, and therefore

$$u \sin \alpha = \frac{u' b}{f}.$$

* Heath, R. S., 'A Treatise on Geometrical Optics,' xvii. and 356 pp., figs., 8vo, Cambridge, 1887, pp. 294–6.

The last image is always formed in air, so that $u' = 1$, and therefore finally

$$u \sin \alpha = \frac{b}{f}.$$

This numerical measure of the aperture may be justified by general reasoning. Other things being equal, it is clear that the numerical measure of the aperture ought to vary as the diameter of the pencil. Next suppose we have objectives of the same diameter of opening, but of different focal lengths. Imagine rays traced backwards through the two objectives in succession from the same object. The incident rays are nearly parallel, and since the openings of the objectives are the same, they will admit backwards the same number of rays. But these rays will be concentrated to a smaller area by the lens of shorter focal length than by the other, the linear dimensions of the areas varying as the focal lengths, but their brightness being the same. Reverting to the original arrangement of the instrument, the objective of shorter focal length will admit the same number of rays from the smaller area as the other will admit from the larger area. The real aperture of the former is therefore greater than the other in the inverse ratio of their focal lengths.

The value b/f is independent of the medium in which the object is placed; it is the same for air, water, balsam, or any other immersion system. A numerical aperture *unity* would correspond to an incident cone of rays in air whose vertical angle is 180°, while with homogeneous immersion the same aperture would correspond to a cone of angle 82° 17′; and with modern objectives the apertures reach 1·40, and sometimes more than this.

The magnifying power of an objective may be measured for a definite position of the image by projecting the image of a stage micrometer upon an eye-piece micrometer. And then we can find the numerical aperture of the objective by means of the formula

$$u \sin \alpha = \frac{m\,b}{u'}.$$

An auxiliary Microscope may be focused to the focal plane, and the linear diameter $2\,b$ of the emergent pencil measured there; then we have only to measure u', the distance of the focal plane from the image to which m refers, and we have the means of finding the value of $u \sin \alpha$.

Conversely, if we know the numerical aperture, the focal length of the object-glass may easily be measured; for using the formula

$$u \sin \alpha = \frac{b}{f},$$

we have only to measure micrometrically the diameter $2\,b$ of the pencil as it emerges at the principal focal plane.

Binocular Vision with the Microscope.—It will be remembered that Prof. Abbe a few years back startled microscopists by the statement * that the action of the binocular Microscope was quite different from ordinary vision, a view which produced an energetic protest from the late Dr. Carpenter,† who had not, however, apprehended the point of Prof. Abbe's argument, which was left untouched. In the last volume of the Encyclopedia Britannica ‡ we observe that Prof. J. G. M'Kendrick (under the head of "Stereoscope") very tersely sums up the result of the controversy (if it can be so called) as follows:—

* See this Journal, 1884, p. 20. † Ibid., p. 486.
‡ Ency. Brit., xxii. (9th ed. 1887) p. 541.

"Prof. Abbe shows, however, that 'oblique vision in the Microscope is entirely different from that in ordinary vision, inasmuch as there is no perspective, so that we have no longer the dissimilarity which is the basis of the ordinary stereoscopic effect, but an essentially different mode of dissimilarity between the two pictures.' In the Microscope there is no perspective foreshortening. There is no difference in the outline of an object viewed under the Microscope by an axial or by an oblique pencil. There is simply a lateral displacement of the image—an entirely different phenomenon to that which occurs in non-microscopic vision. Thus, whilst the mode of formation of dissimilar pictures in the binocular Microscope is different from the production of ordinary stereoscopic pictures, the brain mechanism by which they are so fused as to give rise to sensations of solidity, depth, and perspective, is the same."

HANKS, H.—**Errors likely to occur in Microscopical Observations.**
[(Abstract only). "The hemispherical bosses upon certain diatoms are persistently seen by some as cup-shaped depressions or concavities."]
Report of Proceedings of San Francisco Micr. Soc., July 13th, 1887.

Magnifying-power of Objectives, Measurement of.
[Further letters by F. R. Brokenshire and F. J. George.]
Engl. Mech, XLV. (1887) pp. 540, 561–2.

MARSHALL, W. P.—**On the measurement of the magnifying power of Microscope Objectives**; with exhibition of 1/25 in. water-immersion objective of Powell and Lealand.
[Camera lucida method.] *Midl. Natural.*, X. (1887) pp. 226–8.

POLI, A.—**I recenti progressi nella Teoria del Microscopio.** (Recent progress in the theory of the Microscope.)
25 pp. 8vo, Firenze, 1887. (Sep. repr. from *Rivista Scientifico-Industriale.*)

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XXII., XXIII.**
[Diffraction ancient and modern—Insects' scales.]
Engl. Mech., XLV. (1887) pp. 547–8; XLVI. (1887) pp. 1–2 (3 figs.).

(6) Miscellaneous.

Royal Microscopical Society of the Sandwich Islands.—In 1878* we referred to the establishment of this Society by King Kalakua, a Society which we gather has now ceased to exist. This would appear to be the case from a report of a recent meeting of the San Francisco Microscopical Society, where Prof. F. L. Clarke, of Honolulu, is stated to have "given an interesting account of microscopical matters in the Hawaiian Islands," and in the course of which he "narrated the career of the Microscopical Society which once existed there." The king is now desirous to perfect arrangements for the systematic exploration and study of the natural history of the islands, and in pursuance of this plan the San Francisco Society is to be plentifully supplied with collections of objects suitable for microscopical investigation, and it has been "selected as an agent for the distribution of such material to societies with similar aims in other parts of the world."

Curiosities of Microscopical Literature.—A recent paper† on "Mounting Media, so far as they relate to diatoms," may certainly be ranked amongst the curiosities of microscopical literature, and we are at a loss to understand how it came to be printed. We quote below in full that part of the paper which is headed "Fluids" and it will be seen that the author begins by the statement that he "cannot too emphatically condemn" certain media, such as biniodide of mercury and iodide of potassium, "simply from "the fact that the diatoms will not remain on the cover-glass, but must "necessarily fall to the bottom of the cell." This, to begin with, was a most astounding statement to make after all that has been said on the subject,

* See this Journal, 1878, p. 152.
† Journ. Quek. Micr. Club, iii. (1887) pp. 108–14.

but it is made even more surprising when we come upon the statement lower down in the paper, "I have never seen a slide of diatoms mounted "in biniodide of mercury and iodide of potassium," so that the cannot-be-too-emphatic condemnation of the medium with which the author began was not founded on any practical experience whatever.

The climax, however, is not yet reached, for in a footnote the author, it will be seen, states that he has now learnt that the diatoms will *not* fall to the bottom of the cell, as he had asserted, but will float and press upwards against the cover-glass!

The following is the paragraph:—

> "*Fluids.*—Although certain of these media, such as biniodide of mercury with iodide of potassium, as well as oil of cassia, can be obtained with fairly high refractive indices, yet I cannot too emphatically condemn them for use with the higher powers of the Microscope, simply from the fact that the diatoms will not remain on the cover-glass, but must necessarily fall to the bottom of the cell, which consequently must be very shallow, otherwise the diatoms will be beyond the focus of the objective. With shallow cells in fluid mounts the diatoms can easily get crushed on cleaning the cover-glasses. If it were not for these fatal objections, I should be disposed to regard oil of cassia very favourably as a mounting medium, as these essential oils give great brilliancy; but whether they can be effectually sealed for a permanency I cannot say. I once mounted a slide in oil of cloves, and it remained perfect for some considerable time, but eventually a bubble made its appearance. I have never seen a slide of diatoms mounted in biniodide of mercury and iodide of potassium, and am inclined to think that this medium is very little used.
>
> [Since writing the above I have learnt, with respect to the solution of biniodide of mercury and iodide of potassium, that the medium is of such high specific gravity—viz. 3·02—that any diatoms which may chance to become detached will float in the fluid and press upwards against the covering-glass, instead of falling to the bottom of the cell."]

The paragraph headed "Canada Balsam" is, however, still more wonderful than the preceding, as the author makes this statement:—"The only "objection, to my mind, against this medium is that its refractive index "is not sufficiently high for the new immersion lenses"! Let us put the refractive index of Canada balsam at its lowest limit and call it 1·52, where are these new immersion lenses which, according to the author, have a higher "refractive index"? The simple explanation no doubt is that the author was quite unaware of the principle on which the use of media of high refractive index depends, but that does not make it any the less lamentable that such matter should have been presented in a scientific paper to a Microscopical Society at the present day.

"A QUEKETT CLUB-MAN."—**My Microscope and some Objects from my Cabinet.** A simple introduction to the study of the "infinitely little."
78 pp., 5 figs., 8vo, London, 1887.

American Society of Microscopists—Pittsburgh Meeting.
Amer. Mon. Micr. Journ., VIII. (1887) pp. 156–7.
Microscope, VII. (1887) pp. 248–50, 269–74.

DALLINGER, W. H.—**The Marvels of Microscopy.**
[Presidential Address to Devonshire Association for the Advancement of Science, Literature, and Art.]
Western Daily Mercury, 17th July, 1887.

Mayall, J., jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) (*Contd.*)
[*Transl.* of the Cantor Lectures.]
Journ. de Microgr., XI. (1887) pp. 240-6 (1 fig.), 269–75 (2 figs.), 335–41 (9 figs.).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Solid Medium for the Culture of Micro-organisms.†—Dr. Schenk recommends the outer layers of the white of the eggs of marsh fowl and waders as a suitable medium for breeding micro-organisms, on account of its great transparency when coagulated at temperatures of 65°–70° C. This albumen can be diluted with a fourth of its volume of water before coagulation, and can be mixed with salt, dextrin flour, sugar, glycerin, &c. Of course discontinuous sterilization must be employed as usual.

New kind of solid Blood-serum—Blood-serum Plates.‡—Dr. P. G. Unna states that by the addition of peroxide of hydrogen and carbonate of soda to blood-serum he produces a fluid which coagulates at a high temperature, can be easily sterilized, and preserves its transparency and suitability as a nutritive medium for micro-organisms.

The procedure is as follows:—To a small quantity of calf's blood-serum hydrogen peroxide is added drop by drop, and the mass kept agitated until the brownish-yellow mixture clears up and assumes quite a white colour. The quantity of peroxide of hydrogen added is equal to about half the volume of the serum, and as the commercial fluid is acid, a 2 per cent. solution of sodium carbonate must be added until a slight alkalinity is perceived. It is then filtered until quite clear. The serum is then solidified in Koch's apparatus at a temperature of 90°–120°, according as less or more peroxide and carbonate have been added. The condensation water having been poured off, discontinuous sterilization is continued until sufficient.

For serum plates the author adds 10 per cent. gelatin or 6 per cent. agar-agar to the mixture if the blood-serum have lost its susceptibility to coagulate owing to an excessive addition of alkali.

Preserving cultivations made by Koch's plate method.§—Dr. C. Garré removes a piece of gelatin 2–5 sq. cm. in size, and in which is the colony to be transplanted to a slide, with a thin moistened knife. Should the gelatin layer roll up, it is to be immersed in water, and then the piece is dried under a bell-jar or in a sulphuric acid apparatus until it is reduced to one-half or one-third its original volume. A drop of glycerin-gelatin fluidified at a gentle heat is then added in order to prevent the gelatin tablet from crumpling up. The cover-glass is next imposed.

This manipulation must be carefully carried out, otherwise the colonies, especially if luxuriant, might be damaged. As the drying stops development the organisms may be fixed in any stage of their existence; the colonies do not undergo any change with keeping, and, if desired, by merely removing the cover, they are always available for cover preparations or pure cultivation.

Modification of Koch's plate method for the isolation and quantitative determination of Micro-organisms.‖—Dr. E. Esmarch's modification simply consists in the use of a test-tube, the interior of which is covered with a layer of some nutritive medium, e. g. gelatin. The test-tube, the mouth being covered with a rubber cap, is laid horizontally on a vessel filled with ice-cold water, and turned round with the hands until the gelatin has set.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Allgemein. Wiener Med. Ztg., xxxii. (1887) p. 214.

‡ Monatshefte f. pract. Dermatologie, v. (1886) No. 9.

§ Fortschr. d. Med., iv. (1886) p. 392.

‖ Zeitschr. f. Hygiene, i. (1886) p. 293.

When developed the colonies may be examined with low powers, and even photographed. Individual colonies may also be taken out for further examination. The estimation of the number of germs is made in the ordinary way. The enumeration of the colonies may be made by placing a piece of paper divided into parts of a centimetre and multiplying the number in a given square by the superficies, or a special apparatus devised by the author may be used.

If instead of gelatin agar be desired, it is advisable to add to each 10 cm. of agar 2 or 3 drops of a neutral sterilized solution of gum arabic or isinglass. If anaerobic bacteria are to be studied, the central space must be filled with gelatin while the tube is still in the ice-water.

The advantages of this method over the ordinary plate cultivation are its safety against impurities, the simplicity and rapidity of its execution, the small amount of apparatus, and its facility of transport.

Bacteriological experiments with coloured nutrient media.*—It is well known, says Dr. A. Spina, that indigo-blue turns white when acted on by reducing agents, and recovers its former colour on exposure to the air. It was this property which induced the author to make some experiments in order to ascertain if it could not be made available for cultivation research.

A test-tube was half filled with the following solution:—0·5 phosphate of potash, 0·5 sulphate of magnesia, 1·0 tartrate of ammonia, and 100 distilled water; and this stained with two or three drops of a watery solution of sulphindigotate of soda. The coloured fluid was inoculated with some drops of putrid blood, the test-tube plugged with cotton wool, and incubated at 38°. After three or four days the fluid was decolorized, and the bacteria much augmented in number. The nutrient medium acquired the appearance of thin milk, and only on the surface was a blue layer evident. If the tube was shaken the fluid became blue again, and white when put in the incubator again. Methylen-blue behaves in a manner quite similar.

The objection might be raised that the loss of oxygen was due, not to the bacteria, but to the nutrient medium. That this is not the case the following experiments prove:—(*a*) If a test-tube filled with the coloured medium be inoculated, and after having been decolorized in the incubator, and then sterilized, it rapidly becomes blue, but no further decoloration ensues, although it remains several days in the incubator. (*b*) If a test-tube filled with the coloured medium, and having been sterilized, be kept for a week at a temperature of 38°, no decoloration of the fluid takes place. Experiment also shows that the loss of oxygen was not produced by means of the chemical products of the proliferating bacteria. It was remarked before that shaking or warming restored to the decolorized fluid its original hue. This is explicable only on the assumption that the white methylen-blue or indigo takes up oxygen, and the correctness of this view is shown by the following experiment:—A glass tube filled with the stained and inoculated fluid is melted up at the open end after all air has been expelled, and decolorized in the incubator. In this case shaking will not bring back the blue colour.

From fluid the author passed to solid media, of which he employed two—(1) meat-peptone-gelatin and (2) meat-peptone-agar. A weak solution of the former, stained and inoculated, and kept at a temperature of 22°, became decolorized below the colony in about three days. (The bacteria used were developed on potato, and from the air, but no name is given.) In a few days the decolorized column was quite large, but at the surface the layer in con-

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 71–5.

tact with air still blue. When the tube was shaken up, the whole of the fluidified gelatin became blue. The return of the blue obviously depended on the inclosed air, for it disappears almost completely if the fluid be kept from contact with air by pouring oil over it. (2) Meat-peptone-agar possesses an advantage over the foregoing in that it does not reduce the methylen-blue. For staining, one-third of a tube full of this medium with two drops of a watery sterilized concentrated solution of methylen-blue were employed. After sterilization and inoculation with the potato-grown bacillus, there appears, after about three days at a temperature of 22°, a decoloration of the superficial layers of the agar, and this in six days amounts to about 1·5 cm., while the colony itself seems slightly blue. The loss of colour proceeds more rapidly than the growth of the vegetation, and the decolorized gelatin is, as is shown by microscopical examination and inoculation, free from bacteria.

Numerous bacteria were found to be incapable of reducing either of the dyes, and the author believes from this that he has hit upon a way of ascertaining certain chemical relations between bacteria and nutrient media.

HEYDENREICH, L.—**Sterilisation mittels des Dampfkochtopf (Papin'scher Topf) für bacteriologische Zwecke.** (Sterilization by the steam digester (Papin's digester) for bacteriological purposes.)

[The author finds that a nutrient fluid placed close to the source of heat, in the water, quickly acquires the surrounding temperature of the superheated steam, if only the walls of the glass vessels be not too thick, the air as far as possible removed, and the quantity of the nutrient fluid not too great. And also that as no bacteria or fungi can withstand steam at a temperature of 120° for 5–10 minutes, it may therefore be considered that 15–20 cc. of fluid is safely sterilized if the thermometer keeps at 120° for 5–10 minutes, and if the air has been previously carefully removed (the manometer marking two atmospheres.)]

Zeitschr. f. Wiss. Mikr., IV. (1887) pp. 1–24 (4 figs.).

KELLICOTT, D. S.—**Notice of some Fresh-water Infusoria, with remarks on collecting and preserving these delicate animals.**

Microscope, VII. (1887) pp. 225–33 (4 figs.).

NASMYTH, T. G.—**Methods for cultivation of micro-organisms from water.**

Sanit. Record, 1887–8, pp. 16–9.

ROHRBECK, H.—**Ueber störende Einflüsse auf das Constanthalten der Temperatur bei Vegetationsapparaten und über einen neuen Thermostaten.** (On disturbing influences on the constancy of the temperature in culture-apparatus, and on a new thermostat.)

Centralbl. f. Bacteriol. u. Parasitenk., II. (1887) pp. 262–5, 286–90 (3 figs.).

VIGNAL, W.—**Sur un moyen d'isolation et de culture des microbes anaérobies.** (On a method of isolation and culture for anaerobic microbes.)

Ann. Instit. Pasteur, 1887, pp. 358–9.

WILFARTH, H.—**Ueber eine Modification der bacteriologischen Plattenculturen.** (On a modification of the bacteriological plate-cultures.)

Deutsche Med. Wochenschr., 1887, pp. 618–9.

ZÄSLEIN, T.—**Ueber den praktischen Nutzen der Koch'schen Plattenculturen in der Choleraepidemie des Jahres 1886 in Genua.** (On the practical use of Koch's plate-cultures in the Genoa cholera epidemic of 1886.)

Deutsche Medicinische Ztg., 1887, pp. 389–91.

(2) Preparing Objects.

Methods for killing Invertebrata.*—For the preservation of animals, Prof. F. E. Schultze points out, it is desirable that they should seem as lifelike as is possible, or that no changes should occur to prevent them from being useful for fine microscopical work. Care must be taken to fix the animal in the extended condition, and to prevent the tendency to contrac-

* Tageblatt 59 Versamml. Deutscher Naturf. u. Aerzte, 1886, pp. 411–4. Cf. Biol. Centralbl., vi. (1887) pp. 760–4.

tion. To effect this two methods are in vogue; the one acts with rapidity sufficient to prevent contraction, the other kills slowly by means of some paralysing medium. Absolute alcohol, osmic acid, sublimate solution, chromic acid, and other mineral acids are agents of the rapid process.

Paralysis is produced by slow cooling, or gradual warming, or even by immersion in boiling water; but good service is rendered by alcohol chloroform in watery solution or vapour, sulphuric ether, prussic acid, carbonic acid, atropin, nicotin, strychnin, chloral hydrate, cocain. As suitable reagents for some of the divisions of the Invertebrata, the following are recommended:—

Rhizopoda.—For rapid fixation, osmic acid, and after-treatment with picrocarmin, or absolute alcohol, sublimate, and chromic acid. Chinin in weak solution produces palsy of the protoplasm.

Infusoria.—For paralysing ciliary action, chloroform, soda or seltzer water. For killing quickly, osmic acid, sublimate, absolute alcohol, or chloral hydrate. Keeping animals alive but paralysed, salt solution. Regulated compression under cover-glass for purposes of observation effected by melting away wax supports with heated needles.

Spongia and Cœlenterata.—For sponges no reliable method is known. For Hydromedusa, Scyphomedusa, and Ctenophora, the rapid action of osmic acid. At Naples, polyps are killed rapidly with success by a boiling mixture of equal parts of sublimate and acetic acid. With Siphonophora, paralysing with chloral hydrate is excellent. For Pennatulida with large polyps the gradual addition of fresh water. For histological work, Anthozoa may be paralysed with chloral, but this, like cocain, sometimes gives rise to contraction and deformity. For museum specimens, Anthozoa should be killed suddenly as with glacial acetic acid.

Echinodermata.—Casting of the arms may be avoided by imbedding star-fish in sand. The colour of star-fishes may be retained by immersing them for about 6 hours in Wickersheimer's solution.

Worms.—Some alcohol poured on the surface of the water in which the worms are, or chloroform water, acts as a paralysing agent. Warm solution of corrosive sublimate or picro-sulphuric acid. Nemertines remain extended in chloral hydrate, yet much depends on the degree of concentration of the paralysing fluid. Sudden heating over the flame of a spirit-lamp kills Trematoda. For Polychæta, alcohol. It is very difficult to obtain Rotifera in the extended condition. Carbonic acid water, chloral hydrate, cocain, followed by hardening in osmic acid or cocain solution cooled in ice, all recommended. On Bryozoa the last named medium has the same effect; chloral is not always satisfactory for the marine forms.

Mollusca.—Hot water for fixation. For slugs, tobacco smoke or concentrated sublimate may be used. Chromic acid should be altogether avoided as it renders them too brittle.

Tunicata.—Large animals are killed by passing a glass tube into the two openings and then injecting glacial acetic acid, alcohol, or Kleinenberg's fluid. Small species may be killed by pouring some alcohol or Kleinenberg's fluid and spirit on the top of the water.

Influence of reagents on the Fertilization and Segmentation of the Animal Ovum.*—Drs. O. and R. Hertwig who have previously demonstrated that the ova of the sea-urchin became weakened by immersion in sea water, and therefore became more susceptible to hybridization or polyspermia, i. e. to the penetration of several spermatozoa, now discuss the

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 120–4 (7 pls.).

effect of various chemical reagents of higher temperature, and of mechanical injury on the ova of *Strongylocentrotus lividus*, and also the effect of external agents on the sperma.

(1) Ova before fertilization. (*a*) Nicotin. A mixture of one drop of concentrated nicotin solution with 100 grms. sea water acting for 3–5 minutes, or with 1000 grms. sea water acting for 10–15 minutes. By stronger solutions or by longer immersion the degree of over-fertilization can be increased. By immersion for one hour in a solution of 1 : 100 the ova were not killed. (*b*) Morphia hydrochlorate solutions of 0·1–0·2 per cent. must act for one hour. Solutions of 0·4–0·6 per cent. produced after 1/2–1/4 hour a few cases of polyspermia. (*c*) Strychnine. Solutions of 0·005 per cent. produced a notable influence in 10 minutes, a remarkable one in 20 minutes. Solutions of 0·1 per cent. in 5 minutes effected strong polyspermia; in solutions of 0·25 the ova died in 25–60 minutes. (*d*) Chloral hydrate. A 0·2 per cent. solution produced polyspermia in 4½ hours, while a 0·5 per cent. solution did so in 5 minutes, but after 4 hours the ova did not seem susceptible of fertilization. (*e*) Chloroform (the eggs placed in watch-glasses filled with sea water were exposed to the vapour of chloroform under bell-jars). The ova died in 15–20 minutes, a shorter time produced polyspermia. Chloroform water (chloroform shaken up with sea-water) prevented fertilization, the membrane immediately separating from the ovum. (*f*) Cocain. Solutions of 0·025 and 0·05 per cent. produced polyspermia in 5 minutes. A longer action weakened the ova too much. (*g*) Chinium sulfuricum. A solution of 0·005 per cent. produced perfect polyspermia in 75 minutes; in a shorter time the action was correspondingly less. A solution of 0·05 per cent. produced in 10 minutes and still more so in 15 minutes, very considerable polyspermia.

(2) Sperma before fertilization. (*a*) Nicotin. In solutions ten times as strong as used for ova the spermatozoa were mobile and quite fertile after two hours. (*b*) Chloral hydrate. In 0·5 per cent. solution motion ceased in 5 minutes, but returned on addition of fresh sea water even after 35 minutes' action of the solution, and were fertile. (*c*) Chinin. A 0·05 per cent. solution produced diminution after 5 minutes, and in 35 minutes cessation of movement. When the water was changed the motion only returned slowly and with imperfect fertilization of ova. (*d*) Strychnine. A 0·05 per cent. solution had a retarding influence after acting for 3 hours. (*e*) Morphia. A 0·5 per cent. solution seemed to have no influence. Fertilization was normal after 3/4 hour.

(3) Influence of chemical agents on the course of fertilization. Chinin and chloral diminished the radiation appearances in the protoplasm considerably, and hence inhibited the progress of the internal fertilization appearances. (*a*) The authors immersed the fertilized eggs for 10 minutes in a 0·5 per cent. chloral solution. (1) 1 minute. (2) 1½ minute. (3) 5 minutes. (4) 15 minutes, after fertilization, and then examined a part of the fresh or fixed material. Specimens from each of these four divisions were taken at intervals from 10 minutes to 5 hours after the action of the chloral. The general results did not quite coincide with the previous observations, one part being more, the rest less strongly affected by the reagents, while the changes in the nucleus and protoplasm were not impeded to a like extent.

(4) Effect of chemical reagents after fertilization. (*a*) Nicotin solution (1–100) after acting for 3/4 hour on fertilized eggs, no appreciable result. (*b*) 0·1 per cent. solution of nicotin acting for 10–60 minutes had only slight influence. (*c*) Morphia. A 0·1 and 0·6 solution had only a retarding action; and a 0·5 solution and a 0·4 acting for 30–60 minutes had a

similar effect. (*d*) Chinium sulfuricum in 0·05 per cent. solution acting for 20–30 minutes caused retrogression of the plasma radiation, and this was restored after immersion for a longer period. In 5 minutes the amphiaster underwent a retrogressive segmentation. Preserved material showed that an action of 20 minutes sufficed to prevent or destroy nuclear fission. (*e*) Chloral; in eggs treated with 0·5 per cent. solution for 15 minutes the radiation disappeared, and in 30–60 minutes small projections appeared on the surface. After $5\frac{1}{2}$ hours the ova lost their susceptibility to impregnation. (*f*) Cocain acted like chloral and chinium sulfuricum.

(5) Results of thermic action on the products of reproduction. (1) Eggs kept in sea water at a temperature of 31° C. (*a*) 10 minutes; penetration of spermatozoa abnormal and incomplete: after $1\frac{1}{4}$ hours no copulation of nuclei took place. (*b*) 20 minutes; greater part of the ova fertilized by two to three spermatozoa. In $2\frac{1}{2}$ hours segmentation began; somewhat impaired. (*c*) 45 minutes; fertilization, usually by three to four spermatozoa, sometimes by five, rarely by two (15 ova—56 sperms). (*d*) 60 minutes; fertilization by three to five spermatozoa, rarely by seven or eight: no segmentation observed. (*e*) 90 minutes; fertilization by three to four spermatozoa: no reaction of the female plasma. (2) Ova heated to 55° C. for 5 minutes were killed, drops of albumen separating out. (3) Heated to 50°, 47°, 45°, 42°, 41° C. for 5 minutes, no fertilization. (4) Heated to 39°, 37°, 36° C., fertilization took place, no segmentation. (5) Heated to 34°, 32°, 31° C. for 5 minutes, fertilization and segmentation with subsequent "monster" formation.

(6) Effect of mechanical injuries. Ova shaken up in a test-tube half filled with sea water for 20–30 minutes. The gelatinous membrane separated from the yolk-sac. The otherwise undamaged ova were as a rule fertilized by one spermatozoon. Ruptured ova may be impregnated by several spermatozoa.

(7) Preservation. Eggs were killed in picro-acetic acid, carefully washed, and put in 75 per cent. spirit. Staining with lithium carmine or Grenacher's borax carmine (24 hours, extraction with 75 per cent. spirit acidulated with 1/2–1 per cent. hydrochloric acid). Finally absolute alcohol; then mixture of equal parts absolute alcohol and oil of cloves; evaporation of the alcohol (best under a bell-jar and with vessel filled with strong sulphuric acid close by) dammar or glycerin. Gradual transference from one reagent to another brought out the nuclear figures more clearly than when those operations were quickly performed.

Preparing Tendon-cells and Cells of the loose Subcutaneous Tissue.*— Cap.
Dr. A. Dogiel obtained very good preparations of tendon by placing rat's tail in Grenacher's alum-carmine for two or three hours, or still better, for a week or even a month. The tendon bundles swell up and become transparent, and the cells appear beautifully stained. The elastic fibres stand out very clearly. The same effect may be obtained if tendon be placed in a saturated solution of potash or ammonia alum, and afterwards staining with Grenacher's carmine, alum logwood, hæmatoxylin, eosin, &c. Mounted in glycerin, the preparations keep for a long time, but afterwards a slight decoloration takes place. Permanent preparations of tendon are better placed in spirit, then oil of cloves, wherein they are teased out, then dammar or balsam. For the subcutaneous tissue it is recommended to take a piece free from fat from the inguinal or abdominal region of a mammal, and having spread it out, to stain with a concentrated solution of fuchsin, diluted with an equal volume of water, and then stain under the cover-

* Anat. Anzeig., ii. (1887) pp. 139–42.

glass, where the preparation lies in half per cent. solution. For permanent preparations picrocarmine, glycerin.

Preparing Medullated Nerve-fibres.*—Dr. T. Boveri, when examining medullated nerve-fibres, used the sciatic nerve of the frog, which was treated in the following way.

The nerve, carefully cut out from a frog recently killed, was stretched out according to Ranvier's method, and placed for four hours in a half per cent. solution of hyperosmic acid. It was then washed in distilled water, and hardened in 90 per cent. spirit. Pieces of nerve about 6 mm. long were then stained in a concentrated solution of acid fuchsin for twenty-four hours, and afterwards treated for a similar time with absolute alcohol. For cutting, the object was imbedded in paraffin. The author found that osmic acid gave good results if the 1 or 0·5 per cent. acid had come into actual contact with the nerve-fibres. In practice the central fibres of a bundle were only partially affected by this reagent, so that the action of water preponderated over that of the osmic acid.

For treating nerves with silver the author indicates the following course:—(1) If a nerve be placed in a 1 per cent. solution of silver nitrate, to which an equal volume of 10 per cent. nitric acid be added, the silver reaction takes place, and the fibrillar structure of the axis cylinder is to a certain extent retained, so that a periaxial space does not arise, owing to shrinking of the axis cylinder. (2) Nerves freshly teased out and exposed to osmic acid vapour on a slide in a half dry state are treated with a dilute watery or alcoholic silver solution. In well-hardened fibres the silver reaction occurs almost at once.

It may be remarked here that a mixture of equal volumes of 1 per cent. silver solution and 1 per cent. osmic acid gives the same reaction on fresh tissues as the silver solution shows by itself; hence this mixture is especially suitable for demonstrating the boundary parts of cells, and also for preserving the elements at the same time.

Demonstrating Sharpey's Fibres.†—Dr. A. Kölliker had only poor results when examining Sharpey's fibres in thin sections of decalcified bones of adults in water or dilute spirit. Far superior were 5–10 per cent. salt solution, acetic acid of various strengths, oxalic acid, and strong hydrochloric acid. Of the stains the most satisfactory was indigo-carmine, by which Sharpey's fibres were stained red, the rest of the bone-tissue blue. A section of the bone cartilage, rendered transparent with concentrated acetic acid, is placed for a quarter to one minute in the undiluted stain; then, after having been carefully washed, mounted in glycerin or balsam. Lithia-carmine and, less so, safranin, stain the fibres and the rest of the bone substance differently. New solid green 3 B, tartrazin Victoria blue B, Victoria blue 4 R, auramin, hæmatoxylin, osmic acid, palladium chloride, picric acid, and fuchsin were without effect.

With the polariscope and crossed nicols Sharpey's fibres appear dark transversely and bright longitudinally; for this accurate vertical focusing is necessary. Elastic fibres, rendered evident by acetic acid, are dark longitudinally. They are to be distinguished from Sharpey's fibres by treating sections with acetic acid, oxalic acid, and hydrochloric acid, or by destroying them with strong cold caustic potash or soda, or by staining (the elastic fibres) with fuchsin or safranin.

In preparations obtained by grinding bone Sharpey's *tubules* contain air, and after the addition of turpentine oil and balsam stand out quite clearly

* Abh. K. Bayer. Akad. Wiss., xv. pp. 423–94 (2 pls.).
† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 644–80 (4 pls.).

(the fluid penetrates the bone-cells and canaliculi). But a short heating of thin plates is better. The author was able to distinguish Sharpey's fibres in the soft and uncalcified condition from those partially calcified.

Physiological Silvering of Elastic Tissue.*—Dr. A. Blaschko states that in the cutis of silver-workers there are frequently found, in places exposed to the light, blue-black spots, which are formed from the penetration of minute fragments of metallic silver into the skin. It is obvious the silver is dissolved in the skin, and separates out from the solution into very fine granules under the influence of light. This reduction of silver takes place in the living tissue, especially in the course of the elastic connective tissue, the fine fibrillations of which are thus rendered manifest.

Preparation of the Retina.†—Dr. P. Schiefferdecker finds the following mixture preferable to Ranvier's alcohol as an isolation medium for the retina:—Aqua destillata, 20 vol.; glycerin, 10 vol.; methyl alcohol, 1 vol.

The eye, cut up, or only the retina is placed in this fluid for several days. A small piece of the retina with some water is placed in a test-tube and shaken up. It is then emptied into a watch-glass and some drops of glycerin and of a cold saturated watery solution of picrocarminate of soda added. It is then stirred up with a needle and placed in a sulphuric acid drying apparatus. The red-stained retina elements are mounted in glycerin. As this method is not always successful, several preparations are necessary. For hardening, the author used Müller's fluid, chromic acid 1–600, and acetum pyrolignosum, one part to three parts distilled water. The latter is especially recommended. Eyes of small animals should be hardened in osmic acid or its vapour, and afterwards treated with Müller's fluid. These small eyes are best hardened before being opened.

Imbedding in celloidin. This must be allowed to soak in for some days, and the cover removed little by little. When the ether and alcohol have so far evaporated that the finger scarcely leaves an impression on the celloidin mass, 50 per cent. spirit is poured in and the mass taken out the next day, when it may be cut. The knife should always be kept wet with spirit. Paraffin imbedding alters the retinal elements, and osmic acid is to be avoided as it gives rise to deceptive appearances owing to precipitation.

Preparing the Mammalian Testis.‡—In investigating the mammalian testis, Herr C. Benda used the following reagents and methods.

For hardening purposes, he imitated Biondi in the almost exclusive use of Flemming's chromic-osmic-acetic mixture (1 per cent. chromic acid 7 vols., 2 per cent. osmic acid 2 vols., glacial acetic 0·3–0·5 gr.). Concentrated picric acid and sublimate also yielded very fair results. The imbedding, cutting, and fixing in albumen-glycerin were accomplished as usual. Staining was effected by a modification of Heidenhain's and Weigert's hæmatoxylin method. The sections remain twenty-four hours at about 40° C. in concentrated solution of neutral acetic acid and oxide of copper, are then carefully washed, darkly stained in aqueous solution of hæmatoxylin, decolorized to a bright yellow in very dilute hydrochloric acid solution (1:300–500). The acid is again neutralized, best in the copper solution; the sections become light bluish-green and are finally dehydrated and mounted. The staining thus laboriously effected is very well defined and graduated, and is also persistent. The portions of testis

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 651–5 (1 pl.).
† Ibid., xxviii. (1886) pp. 305–95 (3 pls.). ‡ Ibid., xxx. (1887) pp. 49–110 (3 pls.).

examined were removed from the living or just-killed animal, and were placed in the preserving fluid in very small pieces.

Preparing Cochlea of Guinea-pig.*—Dr. G. Schwalbe places the fresh cochlea of the guinea-pig for eight to ten hours in Flemming's solution, and after thorough washing, decalcifies in one per cent. hydrochloric acid wherein it requires to remain for twenty-four hours. After the acid is quite washed out, absolute alcohol, xylol, xylol paraffin, saturation with Spee's paraffin at 35°–60° C. If the animal killed with the chloroform is allowed to hang with the head downwards for some hours, a perfectly natural injection of the cochlear vessels is obtained. To isolate these vessels, the following maceration method is recommended:—The cochlea filled with blood is decalcified in three per cent. hydrochloric acid and is then kept at a temperature of 40° in an incubator in the same acid. In one or two days the sheath of the cochlea is so softened that the nervous cochlea and its spiral expansion can be isolated from the basilar membrane, and the ductus cochlearis unwound from the expansion of the nerve. After separating the nerve and the duct the spiral vein can be seen with a low power lying by the ganglion spirale and beneath this the tractus spiralis glomerulorum winding round the nervus cochleæ.

Preparing the Central Nervous System of Acephala.†—For the examination of the central nervous system of mussels, Dr. B. Rawitz recommends (1) absolute alcohol 1 part to 3 parts distilled water. This keeps the parts perfectly and causes a slight isolation of the cells, and yet affords useful pictures after four to five weeks. With Solbrig's one-sixth spirit, the contents of the nerve-fibrils disappeared, and Ranvier's one-third spirit could only be used for one day as decomposition appearances occurred afterwards. (2) Bichromate of potash in solutions of 0·2, 0·05, 0·025 per cent. effected perfect maceration in 8 to 24 hours; after a longer period the tissues became completely softened. For hardening the animal in the shell a 5 per cent. solution was used for 4 to 6 weeks. The animals were then easily separated from the shell. After 8 days in absolute alcohol the ganglia were sectioned. (3) Bichromate of ammonia in 0·1 per cent. solution caused shrinking of the nuclei, and changes in the central nervous system. (4) Chromic acid is said to be as useless as a maceration medium as it is for hardening; even Arnold's chromacetic acid solution produced changes in the tissues. (5) Haller's fluid quite destroyed the nervous elements of the Acephala in half an hour. (6) Osmic acid was of very little use. Solutions of 0·1 and 0·05 per cent. were inferior to spirit or bichromate of potash; with solutions of 1 and 2 per cent. the cells seemed to be scorched. 5 to 10 drops of a cold saturated solution of picric acid to 15 cc. of distilled water effected the isolation of cells in 12 to 24 hours and gave good pictures. The mixture of spirit and iodine used by Fritsch for the brains of fish and followed by bichromate were found to make the nervous system very brittle.

As stains, rubin, safranin and eosin gave the best pictures. Gentian-violet, malachite-green, and Weigert's hæmatoxylin were useless. Ammoniacal carmine and much diluted solutions of "Rosenliqueurs" stain excellently, especially the central nervous network. The objects remain therein 4–10 days; they are then washed in spirit slightly acidulated with acetic acid, then absolute alcohol. Gold chloride in 0·1 to 0·25 per cent. solutions gives good pictures.

* 'Beiträge zur Physiologie. Carl Ludwig zu seinem 70. Geburtstage gewidmet von seinem Schülern,' 1887. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) p. 90.

† Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 384–460 (5 pls.). Cf. *supra*, p. 735.

Preparation of Ova of Ants and Wasps.*—Dr. F. Blochmann examined *Camponotus ligniperda* Latr. and *Formica fusca* L. The ovaries were usually fixed with picric acid or sublimate, and stained on the slide with picrocarmine or borax-carmine. For examining the elements of the yolk, double staining with borax- or picrocarmine and bleu de Lyon are advised. The preparations, not always successful, show in favourable cases a blue staining of the yolk-granules and a rosy colour of the surrounding plasma, sometimes with a tendency to violet. A somewhat similar effect was obtained by the addition of a little picric acid to the turpentine oil used for clarifying. The yolk-sac and the chorion are recognizable from the deep blue they acquire from the bleu de Lyon. Young ova of *Camponotus ligniperda* are noteworthy on account of the rod-like corpuscles containing highly refracting granules, and which after being treated with 1 per cent. acetic acid appear more clearly. The addition of 5 per cent. soda solution to the rodlets causes them to pale in fifteen to thirty minutes, and finally to disappear, while the chromatin masses in the nuclei immediately disappear. Against the bacterial nature of these rodlets is to be said that bacteria from hay-infusion are not altered by immersion for three days in 5 per cent. soda solution. In dilute albumen solution in a moist chamber at 30°, after about twenty-four hours they inflate in places, and finally become quite bladder-like. In trypsin solution they become granular at first, and afterwards are partially dissolved.

Preparing Ova of Mysis Chamæleo.†—Herr J. Nusbaum is of opinion that one method of preservation can never afford satisfactory material for study, as each method gives different results. Thus, in treating fresh ova with Kleinenberg's or Perenyi's fluid we get large and distinct cellular elements, but the yolk is lost very easily; on the other hand, when the ova are treated for a few seconds with hot water and then with bichromate of potash, the yolk remains with the elements, but the latter contract. After the ova had been from twenty-four to forty-eight hours in a weak solution (1 per cent. of chromic acid or bichromate of potash, or for four to five hours in Kleinenberg's or Perenyi's fluid, they were put into 70 per cent. and then into absolute alcohol. The eggs thus hardened were coloured *in toto* by hæmatoxylin, borax-carmine, or red magdala; the first of these was very useful, because, in the early stages of development it gave a different coloration to the not yet modified yolk, and the yolk which was already modified by the influence of immigrated cells. As in all researches on Arthropods, the red magdala gave a perfect staining reagent, as it coloured the eggs and embryos in a relatively short time (a few hours), and very intensely, though sometimes too uniformly.

The hardened and stained egg was put into alcohol, then into a mixture of equal parts of 70 per cent. alcohol and essence of cloves, and then into pure essence of cloves, until it became transparent; it was then plunged for a short time into essence of turpentine, and finally imbedded in paraffin. Sections were made by Schanze's microtome, fixed by collodion and essence of cloves, and put up in Canada balsam.

Preparation of Male Reproductive Organs of Cypridæ.‡—Dr. F. Stahlman teases out the fresh animal in physiological salt solution, and stains with picrocarmine, methyl-green, acetic acid, Schneider's acetic carmine. The best fixation is with hot water from 60–65°, or with hot

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 537–720 (5 pls. and 6 figs.).

† Arch. Zool. Expér. et Gén., v. (1887) pp. 124–5.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 511–2. From Zool. Inst. zu Freiburg i. B., 1886, 33 pp. (1 pl.).

30 per cent. spirit. The latter makes the tissue somewhat too brittle. The best staining results were obtained from Ranvier's picrocarmine, but borax-carmine, lithium-carmine, hæmatoxylin, and eosin were also used. The lime in the shell is extracted by acting on it for twenty-four to forty-eight hours with a concentrated solution of picric acid in an incubator, and the acid removed by immersion for a similar period in water heated as before. Perforation or slight fracture of the shell hastens the staining, &c. Flemming's solution is not very advantageous, because it penetrates too slowly. Lively movements of the spermatozoa of *Cypris punctata* Jur. and *Cyproïs monacha* Müll. may often be perceived after teasing open a receptaculum seminis in three-fourths salt solution. The spermatic filament of an undetermined Cyprid was uniformly stained with methyl-green, and scarcely altered at all by long immersion in concentrated hydrochloric acid or caustic potash.

Preparation of endothelium of the general cavity of Arenicola and Lumbrica.*—M. H. Viallanes anæsthetizes the animal by immersing it for an hour in sea water to which chloroform is added. It is then spread out on a wooden plate and fixed with two pins. The middle zone is opened by a longitudinal incision and the integument reflected and fixed down with pins. A piece of the alimentary canal and of the muscular sheath from the anterior and posterior ends of the body are removed and then washed with water and with an acid 0·01 per cent. solution of silver oxide. It is again washed, and then placed in 36 per cent. spirit until the silver is reduced. Immersion in spirit is necessary, because if reduction take place in water the muscles contract and further observation is rendered difficult. When the silver oxide is sufficiently reduced the piece is removed, cleared up in clove oil, and mounted in balsam. This procedure brings out the endothelial cells covering the muscles with perfect clearness.

In order to show the endothelium covering the interannular septa the following method is useful. The annelid is first syringed with one-third spirit and then immersed for twenty-four hours in 80 per cent. spirit. The animal is then opened, one of the septa (the third is the most perfect and best for observation) isolated, carefully spread on a slide, and examined after being stained with picrocarmine or eosin and logwood. By the action of 30 per cent. spirit the endothelial cells are set free, and only the tissue forming the framework of the septum remains.

Preparing Eggs of Rotatoria.†—Dr. G. Tessin states that it is very difficult to obtain good preparations from the small eggs of Rotatoria. With those of *Brachionus* he usually proceeds by rapidly killing the egg in chrom-acetic acid; no distortion results. From weak they are transferred to strong spirit. Picrosulphuric acid produces great distortion, and sublimate does not penetrate. Staining is only possible with hæmatoxylin, as carmine is useless. Creosote is the best clarifier. Paraffin only penetrates with difficulty.

Examination of Nectarial Tissue.‡—Dr. S. Stadler finds that osmic acid is a test for tannin, which it stains brown to a black or blue violet. If any fatty oils are present the test cannot be employed. The author, who had previously used three kinds of zinc chlor-iodide solution for the examination of the cell-wall and of the cuticle in nectaries, has, on account

* Ann. Sci. Nat.—Zool., xx. (1886) 10 pp., 1 pl.

† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 273-302 (2 pls.). See this Journal, *ante*, p. 94.

‡ Stadler, S., 'Beitr. z. Kenntniss der Nectarien u. Biologie der Blüten,' 88 pp., 8 pls., 8vo, Berlin, 1886.

of the trouble and time expended in making these solutions, now adopted the following method.

The preparation is placed on a slide with a drop of zinc chloride solution; to this is added a drop of a weak iodine solution, and the cover-glass is then imposed. The reaction immediately takes place, and if the chloride is in excess, the iodine colour disappears from everywhere except the stained parts of the preparation. It seems indifferent which reagent is first used.

Mounting Mosses.*—Miss V. A. Latham gives the following directions for mounting mosses:—

"We will take the pretty moss, *Dicranum heteromallus*. The chief beauty in this moss lies in the capsule, and I may remark here that mosses for mounting should be in fruit, and, what is more, ripe. The peristome is very pretty, and we must try and preserve the capsule uninjured. In its natural state, when growing and quite ripe, the calyptra and operculum are thrown off, the peristome unfolds itself, and the spores issue from the capsule, and either fall to the ground or are scattered by the wind. All this should be borne in mind whilst mounting mosses, and if you can show the spores leaving the capsule, and also the calyptra and operculum, so much the better. Gently shake, and remove, with the aid of a small sable brush, as much dirt, dust, and grit as you can. Then place the specimens in clean water, and shortly the leaves will expand and look as fresh and green as when growing. Use your brush, and move them carefully and quickly about in the water to further cleanse them. Transfer to a small bottle of water again, and shake carefully. Change the water, and repeat if necessary. During washing the opercula will probably fall from the capsules; therefore keep a look out. Take from bottle, examine your specimens, and remove ragged and imperfect portions, if any; place upon slip, and see if clean with a low power. If so, you will be lucky. Most probably you will find it necessary to use the brush again, holding the moss under water with one brush whilst you clean with another. You can try placing them in a saucer, and letting the water tap drop on them. Now arrange your moss on a slip, unfold and spread out the leaves gracefully and naturally, and with the capsules placed with an eye to artistic effect, as if growing. Put three small beads or portions of broken glass circles for the edges of your cover-glass to rest evenly upon, so as not to rest upon and burst the capsules, and to prevent tilting. Put on the cover-glass and secure with wire clip; drop the glycerin jelly round the edge of the cover, and it will run under. Now gently heat until ebullition takes place. This operation requires a little practice, but when done successfully, it drives out all air-bubbles, liberates a few spores from the capsule, and makes the leaves more transparent for examination. Should the spores leave the capsule in excess and cloud the field, transfer to clean slip and repeat the process. Good glycerin jelly will set immediately, when you may possibly find the boiling has interfered a little with the nice (that is, natural) position of some of the leaves and capsules. If so, warm the slide until the jelly is in a fluid state, insert the needle under the cover, and replace all straight; at the same time, and by the same means, push under and place in position the opercula.

Occasionally there may be a desire to preserve intact the beautiful fresh green tint of the leaves. In that case, after you have got your moss clean, soak it in glycerin for several weeks until the glycerin has thoroughly permeated and driven out all air from the capsules and leaves. When ready, place a warm slip on your mounting stage, put your moss in

* Scientif. Enquirer. ii. (1887) pp. 156–7.

the centre, and with the aid of a lens arrange as straight a line as possible, seeing at the same time any air-bubbles are dislodged either with a needle-point or gentle pressure of some kind. Apply the jelly, dip your cover in warm water, put over all, and gently press down. In adopting this method, you are not very sure of keeping the moss as artistically displayed as you could wish, but the judicious use of a needle, quickly handled before the jelly sets, will put right any serious defect. Ring and finish as with other slides. This is Captain P. G. Cunliffe's method, and was used by him in preparing his slides for the Manchester Cryptogamic Society, and which were acknowledged by all to be beautifully mounted specimens."

Cleaning and arranging Diatoms.*—Dr. F. S. Newcomer proceeds as follows:—He uses a test-tube 10 in. long and 1/4 in. in diameter, cuts the *Zostera marina* into inch lengths for convenience of boiling, boils to wash out the chloride of sodium, then boils in bicarbonate of soda to break up the fibres of the plant, then washes out the soda, and having poured into a Berlin dish, evaporates the remaining water. Sulphuric acid is then added until the organic matter is completely charred. The mass is then deflagrated with chlorate or nitrate of potash. After the acid is cooled, about a quart of distilled water is poured in gradually, and stirred the while. The acid having been removed, any flocculent material is got rid of by boiling with soap (not more than 10 grs. to the test-tube). When the soap is washed away, the diatoms will be clean and bright. The diatoms are extracted by pouring the material into a Berlin dish; the diatoms will be found at the top and the sand, if any, at the bottom of the dish. It is not advisable to throw away the sand, as the largest diatoms are frequently found among it. The material is preserved in a mixture of equal parts of spirit and water.

Diatomaceous earths require great patience; the Barbados material, in which there are traces of iron, is best treated at first with a concentrated solution of citric acid.

In arranging geometric forms of diatoms a guide slide with micrometer circles is used. On this is placed the cover-glass by moistening the surface of the guide slide by breathing upon it; then centered with a pocket lens. The best fixative for the purpose is that of Mr. Febiger: glacial acetic acid 12 fluid drachms, gelatin 2 drachms, alcohol 1 fluid drachm. The gelatin is dissolved by adding the acid over a water-bath, and after the alcohol is mixed in the whole is filtered. The fixative is then spread across the face of the cover-glass by means of the finest cambric needle. The slide on which the diatoms are to be arranged is then fixed on a turntable, and a ring the size of the cover-glass run on with any anilin ink or colour; the slide is then turned over, heated, and a drop of balsam placed upon it and the cover-glass on it, the anilin ring on the under side being used as a guide. The slide is finished off by running the flame of a spirit-lamp round the edge of the cover-glass. The flame of the lamp must be turned down until it is blue.

Cleaning Diatomaceous Mud.†—Dr. G. H. Taylor does not agree with Mr. C. H. Kain as to the avoidance of muds in the collection of diatoms. If muds are avoided, some of the finest specimens obtainable are missed. The author is now engaged in working up the muds of the North Carolina coast. This mud is most difficult to clean, that is, to eliminate the sand; as much as 250 gallons of water have been used before obtaining enough material in a cleaned state to cover the bottom of a half-drachm phial.

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 128–30.
† Bull. Torrey Bot. Club, xiv. (1887) pp. 141–3.

The great mistake generally made in cleaning marine muds is that not enough care is taken in the first washings with water. The author's method is to remove all sand possible before shaking is commenced, for the violent agitation of a mixture of sand and diatoms is prejudicial to the latter. Only as much raw material should be placed in the bottle or jar as will settle in ten minutes, and this should be repeatedly washed until the water will settle clear in a few minutes. The jar should not be shaken, but rotated, and the sand removed after each settling.

Preservation of recent Pathological Specimens.*—Prof. E. Lund preserves recent pathological specimens by placing them in an air-tight vessel filled with the vapour of sulphuric ether, chloroform, or ether and creosote previously mixed with alcohol. Several thick folds of lint, saturated with one of these solutions, are put at the bottom of the vessel, and the specimens are arranged in trays over it, so that the vapour can have free access to each of the specimens. In this way the specimens are always ready for examination, without being softened or decolorized by immersion in weak spirit and water or other preservative fluids. The cover of the vessel can be made air-tight by a vulcanized indiarubber ring, on which the edge of the lid is firmly pressed, or by allowing it to dip into a groove around the top of the vessel, which can be filled with vaseline, or, better still, with liquid mercury, if the vessel is not to be much moved about from place to place.

COURROUX, E. S.—**On the washing and cleansing of diatomaceous deposits.**
Scientif. Enquirer, II. (1887) pp. 144–7.

QUIMBY, B. F.—**Insect Preparations. I.**
[Collecting. Fluids. Implements (including a mounting and dissecting box, illuminated by a mirror set at 45°). Preparation.]
Microscope, VII. (1887) pp. 197–202.

STOSS.—**Notizen über Anfertigung mikroskopischer Parasitenpräparate.** (Notes on making microscopical preparations of parasites.)
Deutsche Zeitschr. f. Thiermed., XIII. (1887) pp. 202–5.

(3) Cutting, including Imbedding and Microtomes.

Celloidin-Paraffin Imbedding.†—In order to obviate the difficulties and inconveniences inherent in the methods of imbedding in celloidin and paraffin, Dr. Kultschizky has devised a combination of these two media which are manipulated as follows:—The object, taken from spirit, is placed for some hours in a mixture of equal parts of ether and alcohol. It is then removed to a solution of celloidin of any strength; herein it remains for twenty-four hours. From the celloidin the object is transferred to origanum oil, and then to a mixture of paraffin and origanum oil which has been heated to 40°, and finally to melted paraffin. The time which the object remains in the origanum oil, the paraffin solution, and in the melted paraffin, must be determined by trial, as it depends on the characteristics of the imbedded objects.

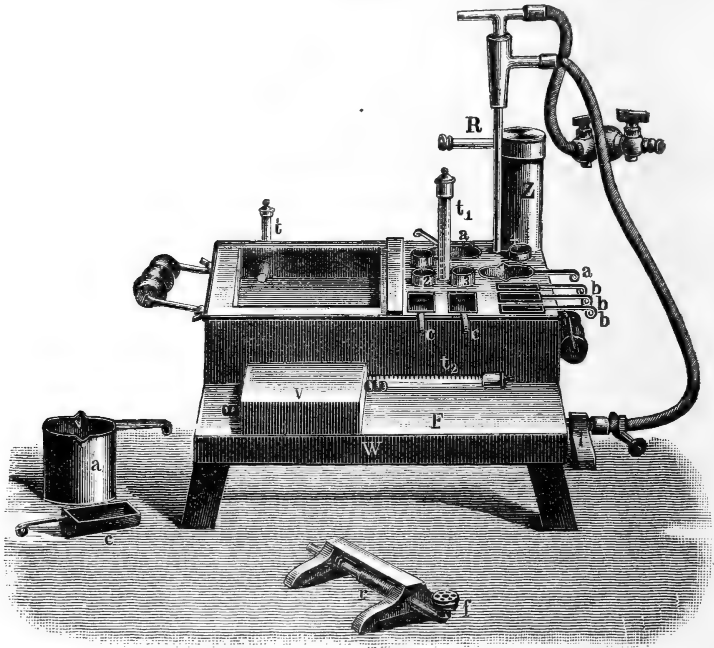
The chief advantages claimed for this method are that very fragile objects can be imbedded; that very thin sections, owing to the celloidin, do not break up, even though the paraffin has given way; that it is not necessary to use an alcoholic drip while cutting; and that sections of the same tenuity as those from paraffin in imbedding can be obtained.

Water-bath for Paraffin Imbedding.‡—Dr. P. Mayer has in conjunction with Dr. W. Giesbrecht and Dr. G. C. J. Vosmaer, devised a convenient

* Scientif. Enquirer, ii. (1887) p. 148.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 48–9.
‡ Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2, 1 fig.

form of water-bath for paraffin imbedding. W is the bath; Z the tube by which it is filled with water; 1, 2, 3, 4, are glass tubes; *a* is a pot for melting and clarifying the paraffin; *b* and *c* are half-cylinders with handles for imbedding; *t* is a thermometer bent at a right angle; the horizontal leg ends in the air-bath, which can be closed with a glass plate. The

FIG. 229.



temperature in the air-bath is about 10° less than the water-bath, and it is used for evaporating chloroform, &c.; t_1 is the thermometer for the water-bath; R is a Reichert's thermo-regulator. The variation in temperature is less than 1° C. *r* is the tube in which the gas and air mix, and *f* a mica chimney. There is a small independent and removable water-bath *v* fitted with water by means of rubber tubes attached to lateral openings. It is supplied with a thermometer t_2, is warmed on the platform F, and is intended chiefly for orienting objects under a simple lens or dissecting Microscope.

Modification of Reichert's Object-holder.*—Dr. J. H. List has made two alterations in this object-holder, by which greater mobility of the ball-and-socket joint and greater space for the play of the knife are obtained. The jaws of the clamp holding the object are now made convex, and the ball-and-socket joint works in one of the jaws. No impediment is therefore offered to the knife, even when the clamp is turned to its utmost. By shortening one of the screws moving the jaws still more room is obtained.

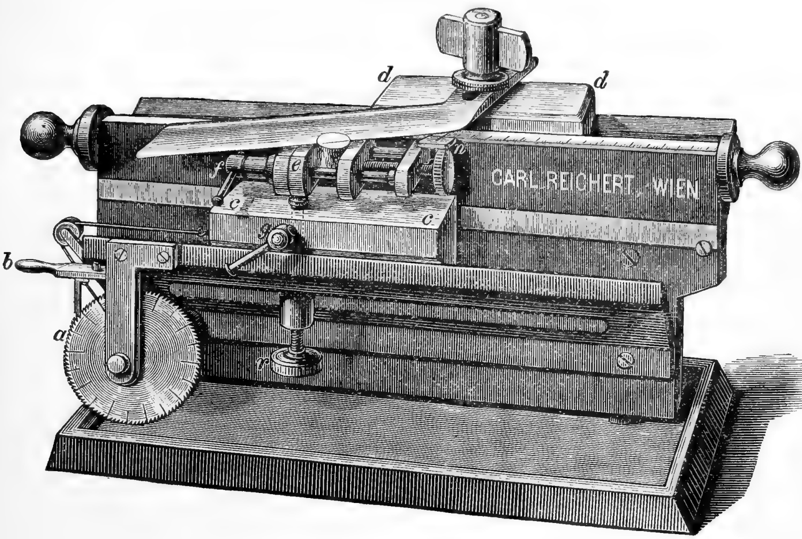
Modification of the Naples Section-smoother.†—In order to increase the size of the Naples section-smoother, which is somewhat too thin,

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 484.
† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.

Dr. P. Mayer advises that strips of gelatin plate, such as are used by lithographers, should be stuck on the cylinder with some very soft paraffin.

Reichert's small Rivet's Microtome.—The only peculiarity, so far as we are aware, of Herr C. Reichert's latest form of this Microtome (fig. 231)

FIG. 231.



consists in the arrangement for raising the object-holder, which is effected by a cord which winds round the axis of the toothed wheel *a*.

LETULLE.—**Microtome de précision.** *Bull. Soc. Anat. Paris*, XI. (1886) p. 355.

(4) Staining and Injecting.

Carmine solution made with Carbonate of Soda.*—Dr. G. Cuccati's improved carmine stain, especially suited for animal tissues, is made as follows:—Warm water 100 cc.; carbonate of soda crystals 20 grms.; mix and heat; add best powdered carmine 5 grms.; stir and cover. When it boils cease heating, and add absolute alcohol 30 cc. Allow to cool in a partially closed vessel. Next day filter, and add to the filtrate 300 cc. H_2O, acidulated with 8 cc. of a 20 per cent. solution of acetic acid. Next add chloral hydrate 2 grms. Decolorize with 100 cc. spirit and hydrochloric acid 1 cc. This carmine acts intensely on the chromatin of the nucleus, showing up the karyokinetic figures quite brilliantly. It stains *in toto* very well tissues treated with spirit, perchloride of mercury, or Kleinenberg's fluid, in five to twelve hours, according to the size of the piece. Staining of sections or pieces *in toto* must always be performed in closed vessels, and before decoloration these must be washed for a few seconds in distilled water. This carmine also has the power of removing the pigment from the eyes of arthropods which have been treated with spirit, while it stains the nuclei of the retinal cells at the same time.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 50-1.

Mayer's Modification of Grenacher's Carmine.*—Dr. P. Mayer thus modifies Grenacher's carmine:—4 gr. carmine are dissolved by boiling in 15 cc. water and 30 drops of hydrochloric acid; 95 cc. of 85 per cent. alcohol are then added, and the mixture then neutralized with ammonia.

Acid Chloral hydrate Carmine.†—Dr. Kultschizky recommends a carmine stain which is prepared by mixing chloral hydrate 10 grms., hydrochloric acid, 2 per cent., 100 cc., and 1 grm. dry carmine. The mixture is boiled from an hour to an hour and a half in a flask. Too much evaporation is prevented by corking the flask, and passing a glass tube through the cork. The solution is allowed to cool for twenty-four hours, and is then filtered.

Thus prepared, the solution gives a red stain, but if a violet be preferred, the sections are to be immersed in a 2 per cent. alum solution afterwards. The omission of the acid gives a neutral solution, which may be used in conjunction with Grenacher's alum-carmine and also picric acid, and a double stain thereby obtained.

New method for making Picrocarmine.‡—Dr. N. Löwenthal supersedes ammonia with the hydroxide of sodium in preparing picrocarmine. Picrocarminate of soda is a very powerful stain, especially for the central nervous system.

(1) The carmine solution is composed of water 100 cc.; sodium hydroxide 1 g.; carmine 0·4 g. The sodium is dissolved in the water, and the carmine added. The solution is effected in the cold in 24 hours, and in 10–15 minutes with the aid of heat. The solution is then filtered.

(2) To solution No. 1, 100 cc. of water is added, and then 20–25 cc. of a 1 per cent. solution of picric acid poured in. The solution, which is rather cloudy, is allowed to stand for about an hour, and is then filtered twice or thrice.

Employment of Perruthenic Acid in Histological Researches.§—Prof. L. Ranvier has a note on the employment in histological researches of perruthenic acid, and its application to the study of the vacuoles of calyciform cells. He has learnt, from a demonstration of M. Debray, that this acid (RuO^4) is reduced in the presence of organic bodies much more actively than in osmic acid. This reducing action is so rapid and so easy that the retrolingual membrane of the frog, although it contains a number of very different elements, becomes completely black when subjected to the influence of the vapour for a few minutes. If we gradually diminish the time of action, it will be found that the membrane is darkened for a diminishing thickness, but all the elements comprised in one layer are equally blackened. If the time of exposure has been very short, the cilia of the epithelial cells may alone be blackened.

This "brutality" of perruthenic acid seems, at first sight, to deprive it of all value as a histological reagent, but Prof. Ranvier reflected on the mode of action of osmic acid, and coming to the conclusion that the result of exposure to osmic acid is a sort of metallization of the organic elements, he judged that those which were the least blackened were the least metallized. If this were so, the mucigen which remains uncoloured in the retrolingual membrane treated with osmic acid would offer the largest amount of disposable organic substance. After the retrolingual membrane has been exposed to the vapour of osmic acid from ten to twelve hours the calyciform cells appear as clear colourless circles. If now submitted to the action of

* Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 46–8.
‡ Anat. Anzeig., ii. (1887) pp. 22–4. § Comptes Rendus, cv. (1887) pp. 145–9.

the vapour of perruthenic acid the membrane blackens, and the calyciform cells are the first to become black, the mucigen alone being coloured, and the vacuoles remaining colourless.

Methylen-blue Staining.*—Dr. C. Arnstein has examined methylen-blue staining on the living frog by injecting into the vena cutanea magna 1 cc. of a saturated solution of this dye. The tongue and palate were stained at once, the nerves were not coloured, the dye being found in the blood-vessels only. One or two hours later the nervelets in the taste papillæ and the thick plexuses of the palate are seen to be blue. The motor-nerve terminations become stained still later. Reichert's pleural muscle may be used to determine the appearance of the stain. "One muscle is removed in two hours, and if insufficiently stained, the second muscle is inspected after another two hours. The eye-muscles are treated in a similar manner, one ball being removed at an early stage, the other at the end of the experiment." Sometimes, however, these muscles do not stain at all, and even if the nerves are well stained they remain so only for a short time, 5–10 minutes about. To retain the colour it is necessary to fix the methylen-blue with iodine, and this reaction turns the blue to brown. A 1 per cent. watery solution of iodide of potassium in iodine dissolved to saturation, is used. The solution is injected through the blood circulation system, and serves also to remove the blood. The frog may be allowed to remain in this solution. The necessary pieces are then cut out and placed in the iodine solution for 6–12 hours, after which the iodine is removed by a thorough washing. Next day the black-brown or grey nerves stand out clearly on a colourless background. Mount in acidulated glycerin. Besides nerves and nerve epithelia, certain other elements are stained during life, such as the cells in the gustatory papillæ of the frog's tongue, certain cells of the palate which lie between the unstained mucous cells, the gland-cells of the membrana nictitans, the cells of the propria in the lingual glands, which as isolation preparations treated with iodine, appears as brown ramified plates. The cells of the cornea, too, are partially stained if the ball be allowed to remain *in situ* for a short time after death. The cornea is then excised and thrown into the iodine solution, but the staining of the corneal cells only occurs when the plexus has been stained during life. Over gold chloride it has the advantage of staining only the cells and their prolongations, and not the lymph channels of the connective tissue cells; those which show the most affinity for methylen-blue are the fat-cells. At one time they stain deeply, even when the nerves are yet uncoloured; later they seem to lose their colour. Sometimes after death they are again very beautifully stained. During life, many red blood-corpuscles show a nuclear stain, but the white corpuscles do not take up any dye.

New Green Dye.†—Dr. W. Krause has been examining a double zinc salt of thiophin-green ($C_{21}H_{24}N_2OS$) as to its utility for microscopical purposes. It is easily soluble in water, alcohol, oil of cloves, chloroform, with a beautiful green colour in which there is a trace of blue. It may be used in conjunction with carmine as a double stain. Fresh tissue hardened in absolute alcohol. Staining with borax-carmine *in toto*, washing, spirit, chloroform-paraffin, paraffin. Sections 0·005 mm. thick fixed to the slide. Collodion, clove oil, paraffin dissolved in benzol, and then removed with absolute alcohol. A drop of a concentrated watery solution of thiophin-green is allowed to act on the moist section for some minutes. It is then

* Anat. Anzeig., ii. (1887) pp. 125–35.

† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) 2 pp.

washed with absolute alcohol. Benzol. Benzol dammar. (If not washed thoroughly the nuclei are blackish instead of red; if too long, the ground substance is too pale.) The stain was used for the electric organ and embryos of the torpedo. The nuclei of fish-corpuscles are red, the plasma green.

New Formula for Burrill's Stain.*—Prof. T. J. Burrill finds the following formula gives excellent results in staining *Bacillus tuberculosis*:—Fuchsin (anilin-red), 1 part; pure carbolic acid 2·5 parts; glycerin (commercial) 10 parts.

The directions for use are as follows:—Add 3 drops of this stain to a drachm (teaspoonful) of distilled or soft water; float a cover-glass, on which a thin film of sputum hardened by heat has been spread, on the liquid and heat to near boiling; remove from lamp and let stand two or three minutes; decolorize in nitric acid (1 part) and water (5 parts); wash in water, and examine, or dry and mount in balsam. Contrast stain, if desired, after the first decolorizing, with anilin-blue.

This formula is much more satisfactory than the previous one, for there is less liability of precipitation of granules on the cover, and the time is greatly shortened.

In the absence of other apparatus, &c., a cheap tablespoon, with the end of the handle bent down to make a level support, answers excellently well for holding and heating the stand, and nothing can be better for the heating than a common coal-oil lamp, the watch-glass, crucible-cover, spoon, or what not being held above the top of the chimney. This is better, too, for hardening the sputum-film than the flame of a Bunsen burner.

Prof. Burrill is sure this stain will keep, for there is nothing in it to precipitate by keeping, as so generally occurs with anilin-oil mixtures.

Staining Elastic Fibres.†—Dr. G. Martinotti fixes and hardens the material with a 0·2 per cent. solution of chromic acid. The sections, after having been well washed in water, are placed for forty-eight hours in a solution of safranin (safranin 5 parts, dissolved in absolute alcohol 100 parts, to which 200 parts of water are added after a few days). The sections are again washed, dehydrated in spirit, cleared up in oil of cloves, and mounted in balsam. The elastic fibres are stained a deep black, the nuclei are of a bright red colour, and the rest of the specimen is stained diffusely red. The elastic fibres come out quite clear and distinct; those in arterial walls are especially suited for this method.

Nerve Staining.‡—Dr. J. Pal remarks that Golgi's method causes a precipitate of mercury upon the cells, for if the sublimate pieces are treated with a 1/2–1 per cent. solution of soda sulphide, the staining is more intense, owing to the formation of sulphide of mercury. Such preparations, after being stained with a bright red, give excellent pictures. The author, however, succeeded in staining all the cells by Golgi's method. By the silver method such good pictures are not obtained, and there is more precipitate than occurs from the use of sublimate. As the chromic acid silver salt is soluble in many dyes, it is necessary, if a contrast stain be desired, to change the salt into mercury sulphide by means of soda sulphide.

Golgi's cell-staining may be used in conjunction with Weigert's hæmatoxylin stain. The sections which have lost, either in the sublimate or silver solutions or in water, their chromic salt, must be placed in a 1/2 per cent. solution of chromic acid for twenty-four hours. Then, without the copper

* Queen's Micr. Bulletin, iv. (1887) p. 24.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 31–4.
‡ Wien. Med. Jahrb., 1886. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 92–6.

treatment, Weigert's logwood may be used in the ordinary manner. For decolorizing these sections, or those prepared by the original method of Weigert, the author proposes a new reagent, with the intent of quite removing the stain from the interstitial tissue, in order that this may be contrast-stained. The blue-black sections are placed in water, to which some alkali (1–2 cc. of lithia solution to 100 cc. water) is added if the preparation does not seem stained a deep blue. From the water the sections are transferred to 1/4 per cent. solution of permanganate of potash for 20–30 seconds. They are next washed with water, and then transferred to the following acid fluid:—Oxalic acid, 1 part; sulphite of potash (K_2SO_3) 1 part; aq. destil. 200 parts. In a few seconds the sections are sufficiently decolorized. They are then stained with Magdala red or eosin (4–5 minutes), or still better, with picrocarmine or with acetic acid carmine. Should any spots remain after the acid solution, the section must be returned to the permanganate solution for a moment, and the process repeated. Should the sections have been treated with copper, the medullary sheath becomes red-brown in the acid solution, and accordingly requires an alkaline bath, or some suitable afterstain, as malachite green. It is advisable that the permanganate solution should be made fresh every time, and should be changed as soon as it shows a trace of brown. So too the acid solution should be promptly replaced by a fresh quantity directly it begins to act slowly. The foregoing method of decolorizing has the disadvantage that each section or preparation requires the greatest attention on the part of the operator.

Exner had treated osmic acid preparations of the central nervous system with ammonia, and thereby brought out many very fine nerve-fibres. Instead of ammonia, Pal used the reagents in the foregoing logwood method. But for the cortex he advises weak ammonia (0·1 cc. ammonia to 100 cc. water). The procedure is as follows:—Very small pieces of brain are hardened in 1 per cent. osmic acid for four to six days, the fluid being changed daily. The piece is then washed with distilled water, laid in absolute alcohol for one or two minutes, imbedded in celloidin and then in wax or paraffin, and then sectioned. The sections are removed from the knife to pure glycerin, or diluted with 1/4 water. Therein they may be allowed to remain for a length of time, but when required for use the glycerin must be thoroughly removed. The sections are then removed with 1/4 per cent. of permanganate solution for ten to fifteen seconds, after which they are transferred to the acid solution. The sections having been carefully washed, are then stained again with some red dye (Magdala red, neutral picrocarmine, acetic acid carmine). Mounting may be done in glycerin, or after dehydration and clearing up, in xylol or creosote in dammar.

Staining Tubercle Bacilli.*—The contribution of Dr. P. Ehrlich on staining tubercle bacilli is chiefly occupied by problematical doctrines about the capacity of the bacterial envelope for taking up dyes. These doctrines simply amount to the well-known facts that alkalis, anilin, and phenol render the envelope more penetrable to stains, that mineral acids penetrate relatively slowly, and that the membrane, when under the influence of acids, is quite impenetrable to the compound molecules of the ordinary dyes.

The author's hints on practice are more valuable than his theories. Thus he remarks that contrast stains, such as Bismarck brown for methyl-violet, and methylen-blue for fuchsin, should be slightly acidulated with acetic acid.

* Charité-Annalen, 1886. Cf. Zeitsch. f. Wiss. Mikr., iii. (1886) pp. 525–30.

For cover preparations the glasses used by him are from 0·01–0·012 in. thick. The sputum is pressed into a thin and even layer, and before separating the two covers they are laid on a hot plate at a temperature of nearly 100° C. until coagulation, shown by opacity, occurs.

For staining, the author usually employs anilin-fuchsin, and for decoloration nitric acid diluted with 2 parts of saturated sulphanilic acid. Decoloration is not continuous, but is performed at intervals of a few seconds, and each time the acid is thoroughly washed away.

For demonstrating tubercle bacilli in fragments of tissue where thin sections are only obtainable with difficulty, the author adopts the following method:—

(1) Stain cover preparations in watery solution of fuchsin for twenty-four hours. (2) Anilin-fuchsin for twenty-four hours. (3) Wash in spirit, or for a short while in sulphanilin nitric acid, afterwards washing with water carefully. (4) Immerse in concentrated solution of sodium sulphide for twenty-four hours, and then transfer to a vessel filled with recently boiled water. (5) Dry the preparation and examine, without contrast staining, in balsam.

Chemistry of Staining.* — Herr P. G. Unna has made a further contribution to the chemical theory of staining. He has previously shown that two reagents, metaphenylenediamine and nitric acid, which outside the tissue at once unite into the brown triamidoazobenzol (vesuvin), when separately introduced into the tissue lose this affinity. He has utilized sections of leprous skin hardened in alcohol for the corroboration of his theory of the occurrence of a chemical process in staining. This tissue was peculiarly suitable as containing within a minimum space the most diverse vegetable and animal substances.

By mixing equal parts of an aqueous solution of metatoluylenediamine and hydrochloric acid with nitrosodimethyl anilin, there results the beautiful deep-blue solution of toluyelene-blue. When sections of the above skin are treated with 1 per cent. of this blue in aqueous-alcoholic solution they stain blue. The vegetable parasites become dark-blue, and by solution in certain acids the general blue colour of the rest of the section is replaced by red in certain regions. But if the two components be introduced separately into the tissue the result is quite different. The difference is carefully analysed, and a chemical explanation offered. It is impossible to summarize the chemical details by which the author seeks to corroborate his point. By union with the tissue a colouring substance may lose its reducibility or another its power of being oxidized. In some cases the section appears to act as an alkali. The paper is an interesting attempt to rationalize our highly elaborated technique.

FERRÉ, J.—**Acide osmique et procédé d'Ehrlich dans la préparation du bacille de la lèpre.** (Osmic acid and Ehrlich's process in the preparation of the bacillus of leprosy.) *Journ. de Med. Bordeaux*, 1887, p. 622.

GEDOELST, L.—**Un nouveau procédé pour préparer le picro-carmine.** (New process for preparing picro-carmine.) *Moniteur du Pract.*, III. (1887) p. 91.

GÜNTHER, C.—**Ueber die mikroskopische Färbung der wichtigsten pathogenen Bacterien mit Anilinfarbstoffen.** (On the microscopic staining of the most important pathogenic bacteria with anilin colouring matters.) *Deutsche Med. Wochenschr.*, 1887, pp. 471–5.

Imada, Y.—**An improved Fluid for Injection.** [*Transl.* from the 'Chū-gwai Iji-schimpō.] *Sei-i-Kwai Med. Journ. Tokio*, VI. (1887) p. 7.

* Arch. f. Mikr. Anat., xxx. (1887) pp. 38–48.

(5) Mounting, including Slides, Preservative Fluids, &c.

Treatment of Sections which have been imbedded in Paraffin.*—Dr. H. Strasser removes the paraffin with benzin or with warmed turpentine, after which the sections are placed in chloroform for a short time and then in 60 per cent. spirit. From the spirit they are transferred to solutions, either watery, or mixed with a little spirit.

When treating serial sections the author has somewhat modified his former method for producing paper plates covered with gum and collodion. Sheets of stout smooth writing paper are pinned down to any flat surface and brushed over with a solution of gum arabic. With the mucilage of gum arabic of the pharmacopœia is mixed 1/5 vol. of glycerin. This addition renders pressing the sheets superfluous. When the gum layer is dry, it is coated over with collodion thinned down with ether to the consistency of glycerin, and 1/100 vol. of castor oil added to impart elasticity. The collodion mixture should be smeared on with a large soft brush, and with practice several layers can be put on in a few minutes. Thus prepared they are folded in the middle, the paper side outwards, and laid aside till wanted. The sections are stuck on with the following mixture:—Collodion 2 vols, ether 2 vols, castor oil 3 vols. Care must be taken that no air remain under the section, and when it is fairly fixed, the surface is brushed over with the same solution. The plates thus prepared are then immersed in benzin or turpentine for a half to several hours. Turpentine is to be preferred for most reasons, while the chief advantage of benzin is that the plates require less careful manipulation. The plates are then placed in chloroform, from which in fifteen minutes or longer they are transferred to 80–85 per cent. spirit, wherein the collodion is gradually hardened.

Fixing Sections.†—Clouding of the shellac used for sticking on sections can be avoided by dissolving the shellac in carbolic acid. But as the acid attacks many tissues—for example, the skin of vertebrates—the author recommends the warm slide to be smeared with an alcoholic solution of shellac, and then allowed to cool. The sections are then placed on dry, and having been carefully smoothed out, are exposed to the vapour of ether. This is most easily and simply done by putting the slide in a vessel, at the bottom of which is some ether. The vessel is then closed, and in about half a minute the sections are saturated with ether, which is afterwards removed in a water-bath. The further treatment is as usual. Softening the shellac with ether vapour is not so safe for brittle sections as the carbolic shellac. As chloroform also softens shellac, the use of chloroform balsam is rather dangerous; it is safer to use turpentine or benzol (not benzin) balsam.

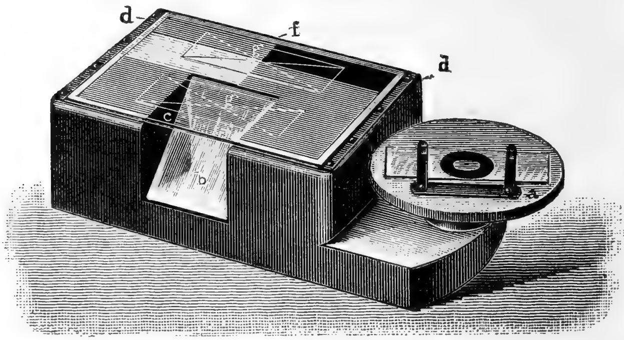
The formula given for the author's albumen adhesive is:—Albumen 50 cc.; glycerin 50 cc.; salicylate of soda 1 gr.; the mixture is to be well shaken, and then filtered into a clean bottle. Is said to keep for at least three years.

Eternod's Turntable "to serve several purposes."‡—Prof. A. Eternod has utilized the body of the turntable (fig. 232), so that it is now available for different purposes, and this is effected without increase of space, a desideratum to many workers. The turntable is at *a*, the upper surface

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 44–6.
† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.
‡ Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 41–2 (1 fig.).

of the body of the stand is filled with a plate of glass *c*, the bevelled edges of which are fixed by a strip of metal *d*. Part of one side is excavated so that a mirror *b* can be fitted in. Beneath one half of the glass plate is a strip of cardboard *f*, stained in different colours, blue, green, red, black, or white; at *g g* are two devices drawn with a diamond for exactly centering

Fig. 232.



objects on the slide. The use of the mirror is for finding specimens immersed in dark staining fluids. Above the coloured paper, objects can be teased out on grounds suitable to their colour.

Wax as a Cell Material.*—Mr. J. E. Whitney recommends the sheet wax used for making artificial flowers as a material for cells. The objection usually raised against wax as a dry mount, is that it sweats, and consequently the mounted objects become obscured by condensed vapours. The author has met this difficulty by the simple plan of coating the inside of the cell with cement, and his experience of this medium after some years and of some two thousand dry mounts, is that no sweating occurs when this material is properly manipulated. Ordinary sheet wax, the fresher the better, as when old it is brittle, and requires to be warmed, is placed in layers one above the other according to the desired thickness; and from these layers which are made to adhere by the heat of the hand, rings are punched out. Suitable punches devised by Mr. Whitney were described in the 'Proceedings' of the American Society of Microscopists for 1884.

The rings having been punched out are placed on a slide previously warmed and cleaned; pressure with the finger causing them to adhere to the glass firmly. The turntable upon which the slide had been placed for the previous operation is now revolved, and the inner and outer edges of the ring smoothed down with a penknife. When this is finished, a coating of some transparent cement is laid over the outer and inner surfaces of the ring. The varnish dries in a few hours, but it is better to leave them for a few days well covered up from dust. When the object is placed in the cell and secured by a minute drop of cement, a thin coat of cement is given to the top rim of the cell so that the cover will adhere firmly. The author then usually finishes off his mounts at once by putting on a coat of cement after the cover-glass has been fixed; for that purpose shellac varnish is

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 153–6.

perfectly safe. If, however, the cement should tend to run in when the cover is applied, the finishing coat must be delayed for a few hours.

Mounting in Fluids.*—Mr. E. Ward writes on this subject as follows:— "There are some microscopic objects that we cannot mount, either dry or in balsam, nor yet in glycerin jelly, because the heat necessary to liquefy the jelly destroys the structure of the object. In such cases we must use fluid, but to seal up the fluid permanently is one of the difficulties of micro-mounting. I have been most successful in the way I purpose to show to-night. I first make a cell of brown cement, and allow it to harden thoroughly. I then spin a second ring of cement when just upon the point of mounting any suitable object; then fill the cell with water or other fluid, and arrange in it the object: place the cover-glass gently down, and fix with a clip just strong enough to hold it in position without causing any convexity, and absorb the exuded moisture by means of blotting-paper. After the clip has remained for an hour or so it may be removed, and another ring of brown cement spun over the junction of cell, slip, and cover-glass. This will make all secure. Brown cement is not suitable if used by itself for any fluids containing alcohol, because the spirit has some action upon this medium. In this case the cell, after being made in brown cement, should be covered entirely with balsam and benzole, and when dry this is again made tacky by a thin line of balsam, which fastens down the cover-glass. A ring of brown cement may be spun over all, and completely seal the mount, which may be afterwards finished in any way desired."

Media for mounting very perishable Artificial Crystal Sections.†—By very perishable crystals Prof. C. Johnston means such as lose their polish or become opaque in Canada balsam as well as in air. Examples of these are potassium and sodium tartrate, potassium nitrate, ammonia-sodium tartrate, and potassium and ammonia-sodium tartrate. Plumbic acetate is especially prone to undergo decomposition. A mounting medium should be transparent, and if possible colourless, enduring as such; of an index of refraction having reference to the substance treated; free from moisture, and not a solvent of the matters it is employed to defend. The author mentions the following as especially worthy of attention.

(1) Finest gum copal dissolved in chemically pure amylic alcohol. (2) Finest gum copal dissolved in chemically pure absolute alcohol. (3) Dammar resin dissolved in rectified spirits of turpentine. In making these solutions no heat is to be used. The gum copal should be broken up to the size of buckshot, set in a warm dry place for a while, and then having been placed in a well dried bottle to the extent of two-thirds its capacity, alcohol is poured in until the bottle seems half full. The bottle is then corked and the solution is left to time. The resultant fluids should be very thick. The absolute alcohol solution is highly transparent, the amylic slightly opalescent. The dammar solution is made in an analogous manner. (4) Dammar resin dissolved in well boiled copaiba balsam. To this latter, number 3 dammar solution is added, and melted by heat until the solution becomes very thick. On cooling it thins and is ready for use. It is of a dark sherry colour but quite transparent, and a preservative of crystalline films as ethel ether of gallic acid. (5) Boiled Chian turpentine dissolved in boiled balsam of copaiba. The turpentine is boiled until, when cold, it becomes nearly hard. The boiled copaiba and the turpentine are then melted together, until the mass, when cold, is too thick to flow.

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 69.
† Johns-Hopkins Univ. Circ., vi. (1887) pp. 79–80.

The colour is a dark sherry, but the medium is transparent and brilliant, and is excellent for sections of potassium nitrate made parallel to the axis.

Fig. 233.

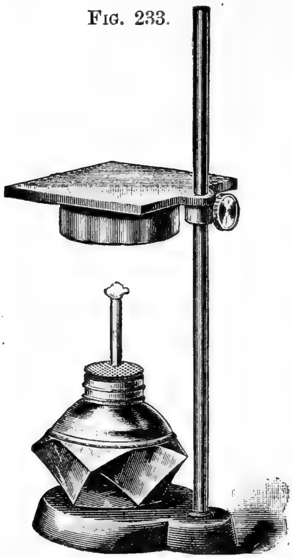
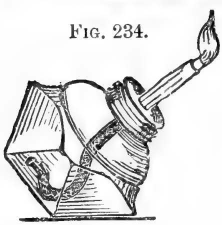


Fig. 234.



Solution number 1 is suitable to perishable crystals, as plumbic acetate, Rochelle salt. Number 2 is best fitted for attaching crystals or sections of any kind, or for holding sections to be ground very thin. Number 3 is preferable to Canada balsam on account of its white colour. It serves well to mount separately halves of the same crystal section, and is a capital cement for these two mounts when crossed. Numbers 4 and 5 are preferred by the author as they are perfectly free from humidity, and though darker than fresh Canada balsam, their tint does not deepen by time. A sixth medium, of which Prof. Johnston has had less experience, but of which he speaks favourably, especially for potassium nitrate, is made by boiling the whitest dammar until the scum is nearly dissipated; the rest of the scum is then spooned off. Rectified spirits of turpentine are then added till the proper tenuity is attained. It is then passed while still warm into a bottle, or the dammar having been boiled may be allowed to cool and then broken up into small pieces; these pieces are then put into a bottle and covered with rectified spirits of turpentine, the solution being left to time to accomplish.

Bausch & Lomb Optical Co.'s Spirit-lamp.—The peculiarity of these glass lamps is that they have nine facets, so that they can either be used upright on a mounting stand, as in fig. 233, or inclined as in fig. 234. The size of the flame may be regulated by a sliding tube. In use the lamp is filled only one-third full.

Briant, T. J.—**New Form of Microscopic Cell** for mounting objects requiring to be examined on both sides.

[A piece of cardboard, the size of the usual glass slip, and having a circular aperture punched in its centre, is pasted between two similar cards with apertures slightly larger. A ring of Miller's cement is then run round the edge of the inner card, on one side of which a cover-glass is fastened, thus forming a fluid-tight cell. In this the object is placed, and is secured by another cover-glass, also fitting the aperture of the outer card. Objects mounted in this way may readily be examined with high powers, both on their upper and under surfaces.]

16*th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club*, 1887, p. 12.

Neville, J.—**New Form of Dry Cell.**

[" Made of vulcanite, which he had named the window-slide. This cell allows the cover-glass to be slipped on and off at pleasure, so that objects may be at once put up for examination, and dust or damp on the glass at any time removed."]

16*th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club*, 1887, p. 12.

Pinckney, E.—**Slide-Index.**

[Considers that the catalogues prepared by Ward and others may serve their purpose as a *record*, but not as an *index*. Every worker needs a reliable slide-index, to which he may turn for instant reference, and he therefore suggests the following:—Take a six-quire blank book, commonly known as "record" form, plain blue lines for writing and one vertical red line about one inch from left-

hand side of page. With a ruling-pen, draw a second similar red line, about half an inch to right of first one. This gives three spaces on each page. Now index the edges, giving each letter its due proportion. In the first space write the generic name, as *Amphipleura*, while in the third space you write the specific name, as *pellucida*, together with the number of the slide. The second space is for a key, or catch-word, and for this purpose a set of abbreviations is used.]

Microscope, VII. (1887) pp. 239–40.

(6) Miscellaneous.

BASTIN, E. S.—**Elements of Botany, including Organography, Vegetable Histology, Vegetable Physiology, and Vegetable Taxonomy.**

[Appendix treating of the Microscope, accessories, staining and mounting, fluids, and micro-reagents.]

300 pp., nearly 500 figs., 8vo, Chicago, 1887.

Bizzozero, G.—**Handbuch der Klinischen Mikroskopie, mit Berücksichtigung der Verwendung des Mikroskops in der gerichtlichen Medizin.** (Handbook of Clinical Microscopy, with reference to the use of the Microscope in Medical Jurisprudence.) *Translated* by *Dr. S. Bernheimer*, with a preface by *Dr. H. Nothnagel.*

2nd ed., x. and 352 pp., 45 figs. and 8 pls., 8vo, Erlangen, 1887.

COLE, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. Nos. 10, 11, and 12.

Sec. I. Botanical Histology, pp. 37–47. No. 10, X. Studies in Vegetable Physiology: Waste products. Glandular structures. (Plate 10. Resin glands from leaf of *Psoralea hirta.*) No. 11, XI. Glandular structures and crystals. (Plate 11. Petiole of Ivy.) No. 12, XII. Growth. (Plate 12. Young twig of *Aristolochia sipho* T. S.)

Sec. II. Animal Histology, pp. 37–50. No. 10. Reproduction in Snails. (Plate 10. Ovotestis of Roman Snail—*Helix pomatia*, Tr. S. × 230.) No. 11. Reproduction and Development of the Liver Fluke. (Plate 11. Liver Fluke—*Fasciola hepaticum* × 4.) No. 12. Reproduction in Tape-worms. (Plate 12. Tape-worm —*Tænia mediocanellata*, L.V.S. × 12.)

Sec. III. Pathological Histology, pp. 37–46. No. 10. Kidney in Leucocythæmia. Leukæmic infiltration of Kidney. Hæmorrhagic Infarction. (Plate 10. Embolic Infarct of Kidney.) No. 11. Tubercular Renal Phthisis. (Plate 11. Tubercular Renal Phthisis.) No. 12. Epithelioma of the Kidney (Cancer of Kidney). (Plate 12. Epithelioma of Kidney.)

Sec. IV. Popular Microscopical Studies, pp. 37–51. No. 10. Growing-point of Stem Leaves. *Eucalyptus globulus.* No. 11. Seeds. (Plate 10. Seed of Sun Ray.) No. 12. Odontophores. (Plate 11. Odontophore of *Cyclostoma elegans*). *Tingis hystricellus.* (Plate 12. *T. hystricellus* × 30.)

JAMES, F. L.—**Clinical Microscopical Technology.** VI.

[Urinary Examinations. Micro-clinical Reactions. Parasites and Fungi.]

St. Louis Med. and Surg. Journ., LIII. (1887) pp. 31–3, 100–2, 167–8.

JENNINGS, C. G.—**The Microscopical Examination of Urinary Deposits.** II.

Microscope, VII. (1887) pp. 202–4 (2 figs.)

[MANTON, W. P., and others.]—**Elementary Department.** Fifth and Sixth Lessons. "Cleanliness is akin to godliness."

[Section cutting and staining. Microtomes. Stains.]

Microscope, VII. (1887) pp. 211–4 and pp. 244–8.

(Cf. *St. Louis Med. and Surg. Journ.*, LIII., 1887, p. 99; comment on motto, which "wants reversing.")

M'CASSEY, G. H.—**Microscopy and Histology for Office Students.**

Arch. of Dentistry, 1887, May.

RAFTER, G. W.—**How to study the biology of a water supply**

19 pp., 8vo, Rochester, N.Y., 1887.

TAYLOR, T.—**Crystalline formations of Butter and other Fats.**

Microscope, VII. (1887) p. 239 (1 pl.).

WEINZIERL, T. RITTER v.—**Die qualitative und quantitative mechanisch-mikroskopische Analyse; eine neue Untersuchungsmethode der Mahlproducte auf deren Futterwerth und eventuelle Verfälschungen.** (Qualitative and quantitative mechanico-microscopical analysis; a new method of investigation of food-products, with reference to their value as food and their possible adulterations.)

Zeitschr. f. Nahrungsmitteluntersuchung und Hygiene, 1887, July, 14 pp. and 1 pl.

PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held on the 24th November, 1886.

The following objects, &c., were exhibited:—

Mr. J. Badcock:
Lophopus cristallinus.

Mr. C. Baker:
(1) New Apochromatic Objectives and Compensating Eye-pieces by Zeiss. (2) Specimens of Bacteria. (3) Diatoms in Cassia Oil.

Messrs. R. and J. Beck:
(1) Petrological Star Microscope. (2) Bacillus of Leprosy. (3) Membrana Ruyschiana.

Mr. T. Bolton:
Eurycercus lamellatus.

Mr. Crisp:
Zeiss's 1/8 in. Apochromatic Homogeneous-immersion Objective.

Dr. Crookshank:
(1) Photomicrographs of Bacteria. (2) *Trichomonas Lewisii* from Sewer-rats.

Mr. H. Crouch:
Grand Model Microscope.

Mr. T. Curties:
Generative Organs of Insects, dissected by Mr. Tatem.

Mr. F. Enock:
Head of Ground Bee, *Colletes Daviesana.* Battledore-wing Fly, *Mymar pulchellus.* Fairy Flies, *Aclayrus incarnatus.*

Mr. F. Fitch:
Mouth structure of Fly (*Dexia*) and Ticks (*Ixodes*) from Madagascar.

Dr. Heneage Gibbes:
Photomicrographs.

Mr. H. F. Hailes:
Abnormal forms of *Peneroplis.*

Mr. J. D. Hardy:
Pond Life (various).

Dr. R. G. Hebb:
Actinomyces (Human) from Capillary of Liver.

Mr. S. J. McIntire:
(1) Pollen of *Victoria Regia.* (2) Seeds of *Pistia stratiotes.*

Mr. A. D. Michael:
Aglaophenia pluma (stained).

Mr. E. M. Nelson:
Amphipleura pellucida in Prof. H. Smith's medium, ref. index 2·4; oblique illumination by Powell's achromatic oil-immersion condenser; Powell's Oil-immersion Objective 1/12 in. N.A. 1·43 and 1/4 in. Huyghenian eye-piece, giving an amplification of 4400 diameters (equal to 36 times the initial power of the lens).

Messrs. Powell and Lealand:
(1) *Amphipleura pellucida* with 1/12 in. apochromatic homogeneous-immersion objective 1·40 N.A. and achromatic oil-immersion condenser. (2) Scale of Podura (*Lepidocyrtus curvicollis*) with 1/12 in. apochromatic homogeneous-immersion objective 1·40 N.A. and achromatic condenser.

Mr. G. Smith:
(1) Rhyolite of Pre-Cambrian age, showing perlitic and spherulitic structure, Wrockwardine, Shropshire. (2) Pitchstone, Ponza Island, showing glass in a condition of strain. (Polarized light.)

Mr. J. H. Steward:
Hydra vulgaris.

Mr. C. Tyler:
Meyerina.

Mr. A. Topping:
(1) Section of Hoof of Horse (double stained). (2) Palate of *Octopus* (double stained). (3) Earth Parasite, *Trombidium* (South Africa).

Mr. J. J. Vezey:
Ciliary Processes of the Eye of an Ox (injected).

Mr. H. J. Waddington:
(1) Alloxanate of Ammonia (polarized). (2) Parabanic Acid (polarized).

Messrs. Watson and Sons:
(1) Type Slides of British and Foreign Foraminifera. (2) Jaw of Mole, long. sect. through teeth. (3) Type Slides of Spines of *Echinus*, *Holothuria*, and *Synapta*.

Mr. T. Charters White:
Album of Photomicrographs.

The second Conversazione of the Session was held on the 27th April, 1887.

The following objects, &c., were exhibited:—

Mr. Badcock:
Lophopus cristallinus, *Floscularia*, &c., from Victoria Park.

Mr. C. Baker:
Apochromatic Objectives by Zeiss. Oil-immersion Objectives by various makers, especially suited for bacteriological work. New Photo-micrographic apparatus complete, with Nelson Model Microscope and Lamp, showing image of *Amphipleura pellucida* ($\times$ 3000) projected on the focusing glass.

Rev. G. Bailey:
Foraminifer? from interior of Chalk Flint.

Mr. Bolton:
Tilmadoche nutans. Elver or young Eel. *Stentor polymorphus.*

Mr. Crisp:
Gold-plated Diatoms.

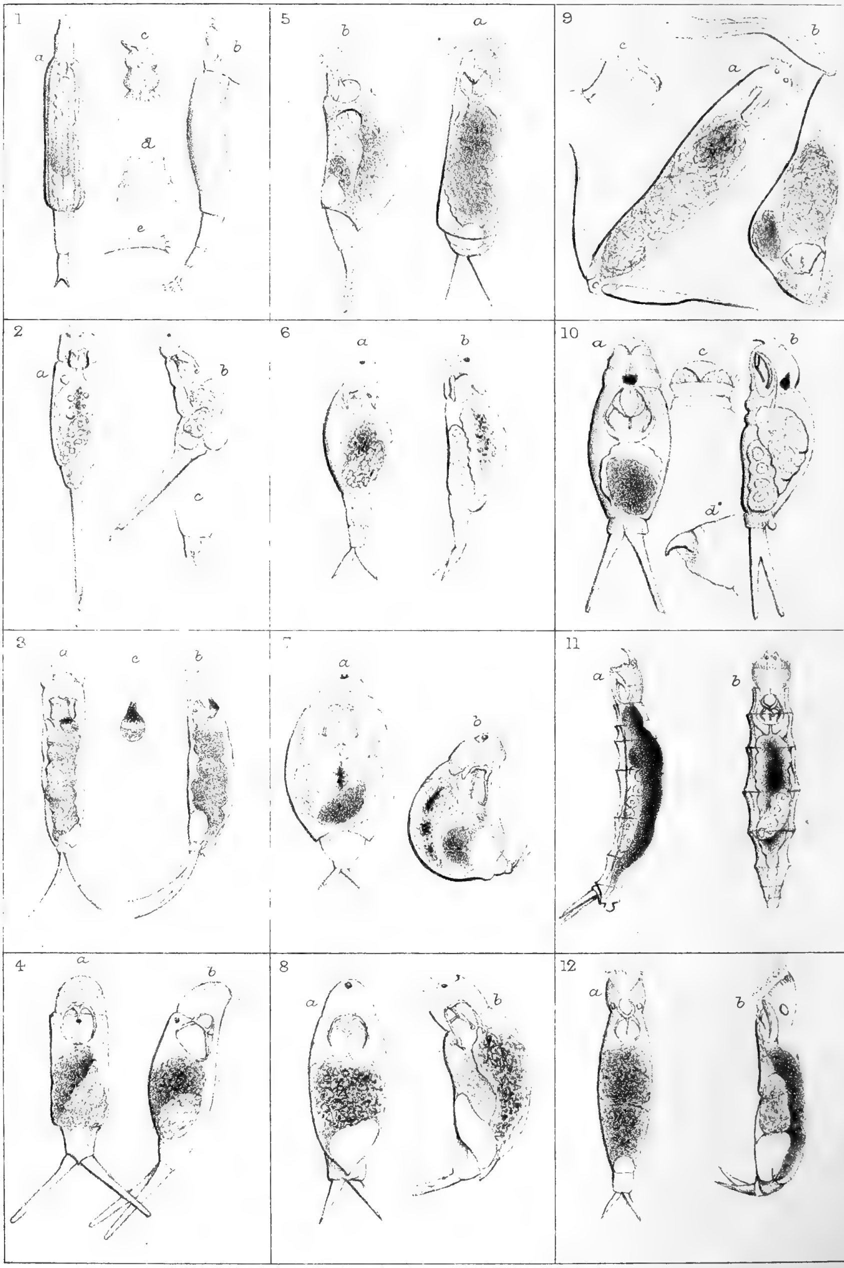
Mr. Enock:
Various Insects and parts of same, showing all organs in natural form and colour.

Mr. F. Fitch:
Mouth, Upper Lip, Gizzard, Ventriculus, and Pancreas of *Dytiscus marginalis.*

Mr. Hardy:
Marine Polyzoa, *Acineta*, and Insects' Eggs.

Mr. Ingpen:
Dendrospongia and Diatoms mounted in Bromide of Antimony.

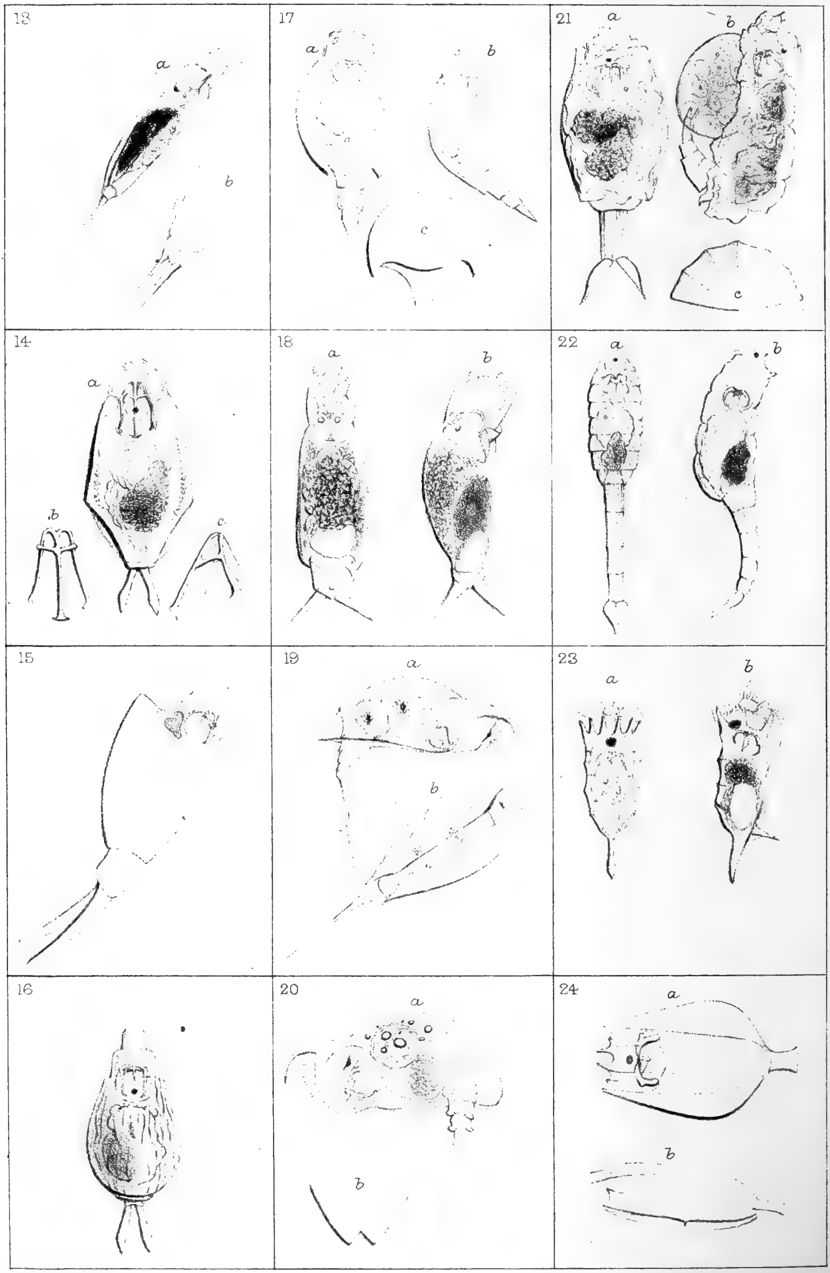
Mr. Karop:
Ciliary Muscles (*Homo*): left in Presbyopia, right in Emmetropia; both from normal eyes.
Mr. McIntire:
Circulation of the Blood in the Heart and Gills of the Tadpole of the Frog.
Mr. Maniland:
Pupa of *Cynips* (sp.) from leaf-gall on *Rosa canina.*
Mr. Michael:
Nothrus spiniger.
Dr. Millar:
Darwinella aurea: triradiate horny spicule.
Messrs. Nelson and C. L. Curties:
A new Photomicrographic Apparatus.
Messrs. Powell and Lealand:
Amphipleura pellucida with 1/12 in. Apochromatic Homogeneous-Immersion Objective and Achromatic Oil-immersion Condenser.
Mr. Priest:
Sponge Structure from interior of Flint found at Bexley in a gravel-pit.
Mr. Rousselet:
Circulation of Blood in Tadpole.
Mr. G. Smith:
Olivene Basalt: Boulder from Glacial Drift of Finchley. Trachydolerite. Twin Crystals of Orthoclase (v. Sanidine). Quartzite, the Wrekin, Salop.
Mr. Suffolk:
Lips of Blow-fly viewed by reflected light, showing entrance to throat, teeth, and exits of pseudo-tracheal canals.
Mr. Topping:
Various groups of Polycystina from Springfield, Barbadoes.
Mr. T. Charters White:
Photomicrographic Camera. Album of Photomicrographs.



P.H.G. del ad nat.

West Newman & Co lith.

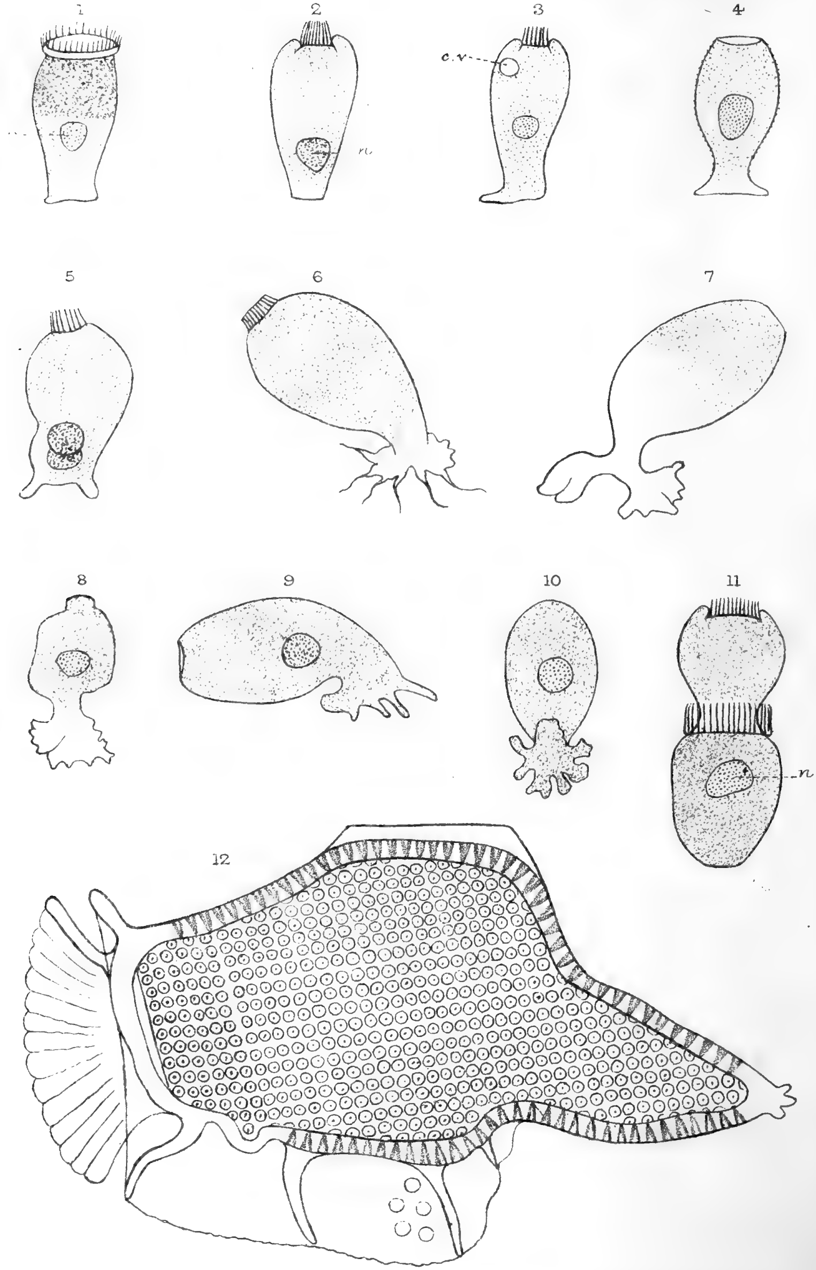
New Rotifera.



PH.G. del ad nat.

West, Newman & Co. lith.

New Rotifera.



J.G.G.del.

West, Newman & Co. lith.

Scyphidia Amœbæa
Dinophysis semicarinata.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1887.

TRANSACTIONS OF THE SOCIETY.

XIII.—*Twenty-four more New Species of Rotifera.*

By P. H. Gosse, F.R.S., Hon. F.R.M.S., &c.

(*Read* 12*th October*, 1887.)

Plates XIV. and XV.

Recent investigations having still further augmented the list of our native Rotifera, I am enabled to present to the Society diagnostic descriptions and delineations of twenty-four new species.

1. *Philodina microps.* Body very slender, closely resembling *Rotifer vulgaris,* both in form and manners, but with eyes distinctly pectoral, small, round, of very pale red hue. Column thick, rounded, with minute hooked proboscis at front: spurs rather small, separated by a horizontal edge: corona in action not wider than head. Length 1/80 in. Marine.

This can scarcely be confounded with any recorded *Philodina.* For some time I felt sure it was *Rotifer vulgaris,* and marvelled that I could

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EXPLANATION OF PLATES XIV. and XV.

Fig. 1.—*Philodina microps.* *a*, dorsal; *b*, lateral; *c*, corona expanded; *d*, retracted; *e*, antenna.
Fig. 2.—*Notommata Theodora.* *a*, dorsal; *b*, lateral; *c*, foot retracted.
„ 3.— „ *limax.* *a*, dorsal; *b*, lateral; *c*, brain and eye.
„ 4.—*Proales coryneger.* *a*, dorsal; *b*, lateral.
„ 5.—*Furcularia lactistes.* *a*, dorsal; *b*, lateral.
„ 6.— „ *molaris.* *a*, dorsal; *b*, lateral.
„ 7.— „ *sphærica.* *a*, dorsal; *b*, lateral.
„ 8.— „ *sterea.* *a*, dorsal; *b*, lateral.
„ 9.— „ *Eva.* *a*, dorsal; *b*, lateral; *c*, mastax, from the right.
„ 10.—*Diglena aquila.* *a*, dorsal; *b*, lateral; *c*, beak, dorsal; *d*, lateral.
„ 11.— „ *Rosa.* *a*, lateral; *b*, dorsal.
„ 12.—*Distemma platyceps.* *a*, dorsal; *b*, lateral.
„ 13.—*Mastigocerca Iernis.* *a*, lateral; *b*, foot-bulb enlarged.
„ 14.—*Diaschiza fretalis.* *a*, dorsal; *b*, trophi dorsal; *c*, *ib.* lateral.
„ 15.— „ *acronota.* Lorica, lateral.
„ 16.—*Distyla lipara*, dorsal.
„ 17.—*Metopidia pygmæa.* *a*, dorsal; *b*, lateral; *c*, transverse section.
„ 18.—*Dispinthera capsa.* *a*, dorsal; *b*, lateral.
„ 19.—*Monura Bartonia.* *a*, lateral: *b*, ventral.
„ 20.— „ *loncheres.* *a*, lateral; *b*, posterior sinus.
„ 21.—*Mytilia pœcilops.* *a*, dorsal; *b*, lateral; *c*, transverse section.
„ 22.— „ *producta.* *a*, dorsal; *b*, lateral.
„ 23.—*Anuræa schista.* *a*, dorsal; *b*, lateral.
„ 24.—*Notholca labis.* *a*, dorsal; *b*, lateral.

not see the eyes in the column. But when I looked to the *pectus,* they were plain enough, though very pale. I know no other species, whether of *Rotifer* or *Philodina,* with so very small a corona in rotation. The whole trunk is fluted. The viscera are tinged with pale smoke-brown, deepest in the abdominal canal. In some examples the hue is rather of a chestnut-brown.

I have examined perhaps half-a-dozen specimens, inhabiting the conferva of marine rock-pools in the Firth of Tay. The species is very shy of rotating, thus differing from other *Philodinæ,* which are characteristically free. At the moment of extruding the column, its broad extremity opens a central orifice (*d*), which is strongly ciliated around its margin, while a row of cilia, apparently *few* and *distant,* is seen fringing the outer edge. The antenna (*e*) consists of (two ?) telescopic joints, its extremity dilated, carrying four divergent setæ. (Fig. 1, plate XIV.)

2. *Notommata Theodora.* Near to *N. aurita, naias,* and *potamis;* from all which it differs in that the eye is small, and quite frontal, while the slender straight foot is protrusile to an immense length, or wholly retractile. Length, when fully extended, about 1/60 in. Lacustrine.

A noble form, of great elegance, and of glassy clearness; colourless, save for a tinge of pale-orange in the tissues of the head (frequent in the kindred species), and the occasional hue of the contents of the stomach. The body has the massive aspect of the species named, but the position of the eye is notable, close to the frontal edge of an ample brain. The form and extreme versatility of the foot, too, are quite peculiar. Sometimes the body is truncate behind, and only the tips of the tiny toes are seen protruding from the hyaline cavity (*c*); when, with lightning suddenness, the foot, like a slender rod of glass, is shot out to a length equalling the whole trunk; and so carried, while the animal darts along with headlong swiftness. The only parallel to this, that occurs to me, is the case of *Rotifer macrurus.* The toes are often turned suddenly, to the right or left, at a joint just above them, the long foot else preserving its perfect straightness. When smoothly swimming, the front often appears as if *auricles* were on the point of developing, but I have not seen them extruded. In retractation the front often becomes pursed-in at the middle. (Fig. 2.)

3. *Notommata limax.* Body vermiform, integument soft; alimentary canal ample, thrown into apparent annulation by alternate constrictions and swellings: brain having a globose terminal bulb partly filled with opaque chalk-masses, and partly with a large eye: foot-bulb contained within the body; toes long, slender, acute, decurved. Length 1/173 in. Lacustrine.

The slug-like softness of the skin gives this species some resemblance to *Diglena permollis;* but it is less versatile in outline. The brain recalls *N. aurita,* the ample sac having a slender tube running through it occupied with opaque specks, which terminates in an ovate expansion. This is, in part, opaque with chalk deposits, and its rounded extremity is filled by a large crimson eye (*c*). There is a likeness to *N. cyrtopus* in the toes; but the general facies is very diverse. Swimming it will suddenly augment its speed by pushing out for an

instant a pair of auricles. There is a distinct tuberculous tail. The whole animal is tinged with pale-yellow. I have seen two examples in *Utricularia* from a lough near Carrick-on-Shannon. (Fig. 3.)

4. *Proales coryneger.* Body nearly cylindrical, rounded in front and rear: foot stout, apparently one-jointed; toes two, furcate, rod-shaped, thick at base, tapering to an obtuse point, very slightly recurved, half as long as body-and-head. Length 1/130 in. Lacustrine.

This obscure form I cannot, on the evidence of a single specimen, identify with any species known to me; though I own it presents little distinctive character. Its long, thick, club-shaped toes form its most obvious distinction: these are usually carried *wide apart.* The figure suggests *Diaschiza*; but I could not detect any dorsal fissure, and the soft skin seems destitute of a lorica. There is a minute red eye in the occiput. In swimming it is rapid, smoothly gliding; darting to and fro, without any appreciable aim. It, like the following, occurred in the swift mill-stream of Kingskerswell. (Fig. 4.)

5. *Furcularia lactistes.* Back much arched, soft and plump, smooth, round: foot stout; toes long, slender, acute, decurved; foot and toes together equal in length to the trunk: a short pointed tail. Length 1/175 in. Lacustrine.

It possesses much elegance of form, and a most restless activity, every instant retrojecting the long foot and toes, with the action of a kicking horse, very forcibly and pertinaciously. It has one very curious habit: it constantly insinuates itself between two stalks of conferva, where it immediately begins to make itself a cell (only just large enough to hold it) by incessantly turning *head over heels.* As soon as it has got its place, it bends the front down to the belly, and begins to roll round and round, without a moment's cessation, for hours. If forced out, it at once begins the same process somewhere else. The habit, which is not that of an individual, but is characteristic of the species, may be compared with the tube-making propensity of *F. forficula* (See H. and G. Rotif. ii. 40, 41). In other respects it has the manners of its genus; as in its sudden and rapid motions, its volutions, and its swift shooting way of swimming. The incus-fulcrum appeared to be a massive pillar, with long, slender, divergent, arching rami: the mallei evanescent.

I met with several examples of this interesting species, inhabiting floating tufts of a floccose conferva, that waved in a rapid rivulet in the village of Kingskerswell. And, a few weeks later, two more occurred in water from Carrick-on-Shannon, Ireland. These had the same form, and identically the same habits, as the Devonshire specimens. And, more recently, I have detected the species in other waters. (Fig. 5.)

6. *Furcularia molaris.* Body ovate, with a thick truncate head, and suddenly diminishing to a long foot, terminated by two blade-shaped, straight, acute toes: back elevated; belly straight. Length 1/240 in. Lacustrine.

A single round eye, well-defined, of ruby brilliance, near the frontal part of a clear saccate brain, marks this rather insignificant species. The trophi are nearly as in *F. lactistes* just described; but the mallei are more developed. An ample alimentary canal, undivided, nearly fills the trunk; and a clear ovary crosses it obliquely, having in

general embryonic vesicles more or less conspicuous. The long foot and toes are carried straight behind, and both extended are about as long as the trunk. It is, as usual, restless, moderately swift, with a smooth gliding course. It is an elegant and attractive little species, which, for lack of any very marked characteristics, I name from the locality in which I found it, — the Kingskerswell mill-stream. Here, on different occasions, I have met with several examples. (Fig. 6.)

7. *Furcularia sphærica.* Body globose dorsally, nearly flat ventrally: foot short, thick; toes small, straight, acute; the dorsum projecting over them with a slight rim or margin, which, laterally seen, looks like a tail. Length 1/240 in. Marine and lacustrine.

In lateral aspect this pleasing little form may easily be mistaken for a deep *Colurus*, till the trophi reveal its true Furcularian character, confirmed by a minute ruby eye at the extreme front; as also by its motions. The head seems not retractile. I first formed acquaintance with it, in half a dozen examples on different occasions, from tide-pools in the Firth of Tay. Then a specimen, recently dead, occurred in fresh water among *Myriophyllum*, thickly studded with *Melicerta ringens* and *Floscularia cornuta.* And presently, to confirm the amphibious habitat, I found one alive in *Utricularia* from a lough in the centre of Ireland. These fresh-water specimens I could in no wise distinguish from the marine. (Fig. 7.)

8. *Furcularia sterea.* Body ovato-cylindric, with a thick truncate head, and subprone face; behind ending in a short, decurved, acute tail: foot short and thick, apparently one-jointed; toes moderate, acute, scarcely decurved. Length 1/173 in. Lacustrine.

Having much in common with *F. molaris*, this is yet quite diverse in facies and habit. The head is of nearly the same thickness as the trunk; the little overarching tail (seemingly a stiff point), and the short but massive foot, are differences that strike one at first sight. The eye is distinct, quite prominently frontal; immediately beneath it the face recedes, and becomes a subprone ciliate surface, applied to the feeding-ground. It is much larger than *F. molaris.* The single specimen seen had a great contractile vesicle, and a small undeveloped ovary. The stomach seemed undivided. The fore-parts were tinged of a delicate yellow hue. It was not much addicted to swimming, but crept vivaciously about the vegetation, grubbing and browsing. I obtained it in water from a little rockery-pond in the grounds of Watcombe Park, the beautiful estate of Colonel Wright, near Torquay. (Fig. 8.)

9. *Furcularia Eva.* Body stout, fusiform, strongly elevated on the shoulder: foot short, indistinct; toes more than half as long as body-and-head, thick for half this length, then abruptly attenuated for the remainder. Length 1/144 in. Lacustrine.

The great length and peculiar form of the toes, which are often thrown back and carried over the back, give a facies to this rather fine species, which at once strikes an observer. Sometimes these organs are extended in opposite directions in a horizontal line, imparting to the animal the figure of the letter T reversed. The mastax is ample; the incus a thick rod, bent in the middle backwards, and ending occipitally in a pair of long and broad scythe-shaped processes: the mallei indistinct.

A slender brain descends behind; but no eye is visible, unless two very pale globules, close side by side, in the very front, are such.

A single specimen only has occurred, whose activity mainly consisted in the vigorous throwing into different positions of the characteristic toes. (Fig. 9.)

10. *Diglena aquila.* Body fusiform: head furnished with a beak: foot short, thick; toes nearly as long as trunk, thick to half-length, then diminished to stiff, straight rods with obtuse points. Length 1/65 in. Lacustrine.

The long straight blunt toes are very characteristic. The proboscis is a broad shield, somewhat as in *Stephanops*, permanent, surrounded by a ring of very long vibratile cilia. It forms, indeed, a hooked beak, shaped like that of an eagle, the edges of which, converging to a point (*c*), are distinctly visible from above, through its hyaline substance.

In manners it is headstrong, abrupt, vigorous; most restless, never pursuing one course more than an instant, but suddenly stopping, and turning round on itself, augmenting its speed greatly for a moment, rushing, or rather *shooting*, forward for three or four times its length, then again and again, but never springing sidewise. I first received it from the middle of Ireland, by the kindness of Mr. Hood, jun.; then in a pond near my own residence; and on several occasions since.

It bears a very close resemblance to a species discovered by Mr. E. C. Bousfield, of which he courteously sent me a drawing, under the name of *Notommata rapax.* This has two conspicuous styles (antennæ?) projecting straight from the head, which I do not see in *D. aquila.* If, however, the two are identical, his specific name has the priority.

None of my earlier examples showed any trace of an eye-spot; but since this article was written I have met with a specimen, in another missive from Mr. Hood, jun., in which was conspicuous a very large black occipital eye, if, indeed, it was not an opaque chalk-mass of the brain. (Fig. 10.)

11. *Diglena Rosa.* Body lengthened, fusiform, annulose, larva-like: proboscis frontal, beak-shaped, within which are two colourless eyes: foot minute; toes small, straight, acute. Length 1/150 to 1/115 in., average width 1/475 in. Lacustrine.

The strong division of the body into annular false-joints recalls *Taphrocampa.* The head, too, resembles that of an insect-larva. The frontal beak is broadly triangular, like that of *D. aquila* just described, and its sharp point, hooked downward, can be seen from above, through its transparent substance. Two well-defined, perfectly colourless bodies, side by side, are also seen through the base of the beak, apparently eyes without pigment. A ring of close-set cilia surrounds the front, behind the base of the beak. The face is truncate, studded with warty eminences. The body terminates in a distinct bulbous tail.

Several examples occurred in conferva-tufts waving in the swift mill-stream at Kingskerswell. All were of a clear horn-yellow hue, with the long alimentary canal full of opaque food-matter. They were restless and swift;—the jaws often protruded from the face, *more generis.* The beak was much more acute and better-shaped in some than in others.

Numbers 2, 9, and 11 of the present series I owe to the kind efforts

of three young ladies, the lovely and accomplished daughters of R. W. Beachey, Esq., of Kingskerswell. I have honoured these three species with their names, as an expression of gratitude for the zeal with which they have kept me supplied—themselves skilful microscopists—from the waters within their reach. Each of these three species was discovered in the prolific mill-stream so often mentioned in this article. (Fig. 11.)

12. *Distemma platyceps.* Body subfusiform; belly flat; head broadly truncate: eyes two colourless globules, remote, occipital: foot rounded; toes taper, acute, slightly decurved. Length 1/144 in. Marine.

Though not unlike certain conditions of *Diglena suilla* and *permollis*, this is distinguished by its two large colourless eyes; and by the fact that while the trophi are of the usual *calliper*-form, the mallei are (or *seem*) attached to the bases, rather than to the ends of the circular rami; while the fulcrum is nearly as long as the mallei. An inconspicuous hooked proboscis is present, which appears retractile. The broad face is of hyaline delicacy, free from corrugations and marks, as if clear gelatinous flesh, and this well defined from surrounding tissues, in all aspects.

Young specimens are very restless and mobile, but an adult was of slow movement. Five or six examples occurred to me in water from a tide-pool near Carnoustie, in Forfarshire. In one the jaws were about half extruded from the face, and (as if by paralysis) could not be retracted, or even moved:—an accident, the occurrence of which I have observed on repeated occasions, in predatory Rotifera. The species is numerous also in a ditch near Goodrington, South Devon. (Fig. 12.)

13. *Mastigocerca Iernis.* Body long-oval; a low dorsal ridge throughout, rising abruptly with an oblique edge in front: toe not so long as lorica; sub-styles two, unequal, the chief one about one-third as long as the toe, *remote from it at the base.* Length 1/80 in.; of head and body, 1/173; of toe, 1/185. Lacustrine.

This species has much resemblance to *M. scipio*; but the regular form of the lorica, and that of its ridge; and the origination of the toe and of the main sub-style, on *opposite* sides of the foot-bulb, so as to be remote from each other,—seem sufficient peculiarities to warrant its distinctness.

Several examples have occurred in *Utricularia vulgaris*, sent me by Mr. W. R. Hood from a lough in the heart of Ireland. Most of these were dead, mere empty loricæ, affording excellent opportunities for precise observation and delineation; others were alive and active. I subsequently found it in water from Cannock Chase, sent by Mr. Bolton. The distinctive characters noted above were conspicuous in all; as also in some vigorous examples from Perthshire. In these the extremities of the jaws were occasionally protruded. I detected, moreover, on the front, three tubercles (one central and two lateral), which seemed fleshy, extensile, and retractile. (Fig. 13, plate XV.)

14. *Diaschiza fretalis.* Lorica pyriform in outline, viewed dorsally; gibbous laterally; each plate cut off obliquely behind, and somewhat excavate: belly nearly flat: toes long, blade-shaped, regularly decurved, acute: head furnished with a beak-like projection. Length 1/185 in. Marine.

This form comes very near to *D. rhamphigera*, but the oblique excavation of each of the dorsal lorica-plates is much more distinct, the frontal beak is more slender, nearly evanescent, and does not appear to be a prolongation of the trophi, which, moreover, are somewhat diversely shaped. There is a red eye on the inner surface of the brain, which I did not perceive in *D. rhamphigera;* and, above all, it is marine.

Only a single specimen has been observed, and that *dead;* but so recently as to leave the internal organs and viscera well-defined, and *in situ.* It was from a tide-pool at Invergowrie. Both species, if they are distinct, require further study. (Fig. 14.)

15. *Diaschiza acronota.* Lorica much elevated, heart-shaped in lateral outline; the dorsal cleft very manifest: head globose, prominent: foot thick; toes stout, long, nearly straight, tapering: eye occipital, pale, very large. Length 1/140 in.; depth 1/400. Lacustrine.

This very remarkable form is another novelty yielded by the mill-stream at Kingskerswell. It seems a very distinct and interesting species; though known, as yet, only by a single dead specimen, in which the eye and the trophi remained in position. The eye is a remarkable feature, from its great size, irregular shape, and pale hue. It occupies nearly half the vertical depth of the body, of a very pale salmon-red. In all these points it resembles the organ in *D. pæta.* The mastax is small: the toes have a backward curve, so slight as to be scarcely perceptible. (Fig. 15.)

16. *Distyla lipara.* Lorica skin-like, flexible, plicate: body flask-shaped, soft and very plump, not pointed behind: toes large, blade-shaped, not shouldered: brain simple; eye minute, occipital. Length, total extended, 1/162 in.; of lorica alone, 1/260 in.; but being very flexible, it contracts to 1/350 in. Lacustrine.

This differs, at sight, from its known congeners by its round, manifestly soft, body, properly egg-shaped, specially in its hind parts, scarcely at all flattened, and destitute of the usual inangulation; the edges of the dorsal and ventral plates approaching close in the middle, and diverging at both extremities, so that the rounded surface is scarcely broken. The soft integument is constantly thrown into deep irregular plicæ, which do not appear to be permanent. A great foot bears, on a condyliform joint, two toes which are widely blade-shaped, longer than the mastax, acute, but not in the least shouldered at the tips. They are habitually thrown up under the belly. The eye is minute, pale-red, occipital. The trophi are normal, long, and capable of being brought to the very front, where they work vigorously. The whole head is protrusile, and very mobile.

The entire animal is transparent and nearly colourless; but the numerous folds and corrugations impart an appearance of a blue-black tinge to the body. The form and outline are subject to slight but continual changes, contracting and expanding. The animal is lithe and active, but not locomotive. A single specimen has occurred in water from Sutton Park ditch, Birmingham, in the orange-coloured sediment which abounds with fine Desmidieæ. (Fig. 16.)

17. *Metopidia pygmæa.* Lorica ovate, much elevated, the back rounded, the edges overhanging; hind margin rounded; ventral surface

flat: foot stout, long; toe apparently single, small, acute. Length, extended, 1/350 in.* Lacustrine.

This seems the smallest of the genus; smaller than *emarginata*, or than *triptera*, which latter was in sight at the same time, for comparison. It is very transparent and colourless, the viscera only just discernible; the trophi, though working, were but shadowy lines. The extremity of the lorica is neither pointed, nor sinuate, but evenly round: its overhanging margins are remarkable, recalling *Notholca scapha*. There are two clear colourless globules at the very front, remote from each other, probably eyes. The frontal hook is carried rather close to the front, and seems incapable of independent motion; it is visible in a dorsal view, as a line parallel to the front. Two minute air-bubbles were in the alimentary canal of the individual examined; but no particles, nor stain, of food, though the tiny creature was industriously picking all the time it was under observation,—an hour or more. It was active and restless, creeping about the floccose, but rarely swimming, and then laboriously. A single specimen occurred in a phial of *Utricularia* sent by Mr. W. R. Hood, from the middle of Ireland. (Fig. 17.)

18. *Dispinthera*, gen. nov., Fam. *Coluridæ*. *Gen. Char.*—Body subcylindric, inclosed, in part, within a lorica open in front and in rear, apparently cleft down the venter: head and foot habitually protruded: head distinct, protected by horny plates, but without a frontal hook: two cervical eyes.

D. capsa. Lorica in most parts soft and flexible: foot stout; toes two, furcate, thick, straight, tapering, acute. Length 1/250 in. Lacustrine.

This apparently new form I found in the sediment of water dipped by Mr. Bolton from "ditch No. 2," in Sutton Park, Birmingham, crowded with fine Desmidieæ. The facies strikes one as very peculiar, and difficult to explain. The front is capable of much protrusion, in a conical form, where a globose tubercle is visible, but only occasionally; and a similar one, but more constant, on the occiput (or rather crown of the head), just below the point of the occipital sheath. The lorica is discernible chiefly about the head; it there projects into several points, which seem very flexible, but constant. When the head is far retracted (which is seldom), an array of spears is left bristling up. Now and then, at the pectus, the integument is seen to fall into a flap, or hanging lip, to be presently withdrawn. The principal shield protects the back of the head, but does not form an arching hood, or frontal hook. The trophi, in several good views, seemed of the pattern (fig. 39 of my paper "On Manducatory Organs," Phil. Trans. 1856); assigned to *Notomm. gibba*. The whole facies recalls one of the smaller *Notommatæ*; yet the two well-defined eyes remove it from them; besides the manifest lorica. It seems to approach the marine genus *Mytilia*, but not very close.

Only a single specimen occurred, in June. It was active and busy, constantly turning and wheeling about, but little given to locomotion.

* The figures in the plates are not drawn to one scale; if they were, this would be not one-fourth as long as No. 13 on the left of it. Each figure is drawn as the containing area will permit, the object being to show as much structural detail as possible.

It suggests the odd notion of a creature carrying its great clumsy head in a bandbox. (Fig. 18.)

19. *Monura Bartonia.* Lorica ovate, moderately compressed, dorsal outline (viewed laterally) one-third of a circle, ending in triangular points, which have the dorsal side slightly excavate: one eye frontal: toe straight, slender, acute, more than half as long as the lorica, shouldered dorsally. Length, from frontal hook to tip of toe, 1/173 in. Lacustrine.

The genera *Colurus* and *Monura* (if, indeed, they are not one) appear to contain a large number of species, peculiarly difficult to define satisfactorily. Yet this and the following are, I think, to be distinguished. The toe and foot together are nearly equal in length to the lorica. I could find no trace of a median line in the toe. Its extreme length and tenuity are notable. Each posterior point of the lorica forms an equilateral triangle, clearly defined from the general area of the lorica, by a line—the base of the triangle. These two triangular termini are of excessive delicacy, and may easily escape a cursory notice. On the extreme front, under the frontal hook, is a small dark crimson eye, like a wart on the face.

Its manners are those of so many of its fellows, remaining long totally withdrawn between the closed lorica-plates in front, pivoting and swaying on the toe-tip incessantly for hours. I first obtained it, in the spring of this year, from a pond known as the Reservoir, at Barton, near Torquay. Since then I have met with single specimens from many localities, and in abundance in the Kingskerswell mill-stream. (Fig. 19.)

20. *Monura loncheres.* Dorsal outline narrowly ovate, lateral nearly semicircular; lorica rounded behind, with a median angular notch: toe shouldered dorsally, excessively long and slender. Total length 1/200 in.; vertical depth 1/550 in. Marine.

The most striking points in this beautiful species are its great depth (from back to belly), making about a half-circle, and the tenuity of the toe, which seems indivisible. This runs to so exceedingly fine a point as to escape notice, except with the most delicate focusing; even with a quarter objective, and the best possible light. The foot, of two condyliform joints, and the toe, together, are fully equal to the lorica in length; viz. 1/400 in. The ventral cleft is narrow, straight-sided, slightly approximate in front, and reaching round to the occiput, posteriorly to a short acute sinus (*b*), whose sides form a right angle. There is a brilliant ruby eye about the middle of a saccate brain, and therefore cervical.

I have examined a number of examples, at different times, in sea-water obtained by Mr. Hood from the Invergowrie tidepools. In one of these I timed the period of emptying the contractile vesicle to be just three minutes. It had this peculiarity, that the emptying was but partial on each occasion: that the bladder suddenly diminished its volume, but not to a point, *nor nearly*. The animal's posturing manners are exactly the same as described in the preceding species. (Fig. 20.)

21. *Mytilia pœcilops.* Lorica pergamentaceous, very flexible, constantly thrown into irregular folds, whence the outline is very variable: the face, in particular, is capable of great protrusion in wide plicate membranes: prevalent figure, foot, and toes, much as in *M. Teresa.* Length of lorica 1/240 in.; depth 1/480 in. Marine.

Though this has many features in common with *Tavina* and *Teresa*, particularly the foot and toes, it has important peculiarities. The *dorsal* outline is like that of the latter, the lateral that of the former; but *both* more rough and uncouth. The skin thrown irregularly into coarse rude folds, occurring at intervals at every part, precludes any fixed form, so that the figure accurately copied has become in a few minutes, though gradually, flagrantly incorrect. The front is large and broadly truncate, capable of pushing out, from its lower part, great membranous sacs and folds, which slowly change every moment, and the use of which is inexplicable. These expansions do not appear to be ciliated. The mastax and trophi are as in its congeners; there is an ample brain, which carries a cervical red eye. The whole back is ridged, —tectiform, not keeled (*c*).

I have observed numerous examples in sea-water from the Invergowrie tide-pools. They have all been remarkably heavy and sluggish in manners, little given to locomotion, wholly lacking the sprightly vivacity of the kindred species.

With one of these specimens a curious phenomenon occurred, which I cannot at all explain (see *b*). The animal was jerking and shaking itself, as if either wishing to be free from an annoyance, or else tearing some prey. Having got it somewhat turned, I saw that it carried, between its bent-up foot and its much developed face, what appeared an *egg*, of dark granular substance, as if just laid, of a pointed-oval form, reminding me, in shape and spotting, of a tern's egg. Whether it was a real egg, or no; if so, whether its own;—I could not tell. It appeared uninjured; and was firmly held for several hours,—as long as the *Mytilia* lived. By-and-by the interior of the "egg" displayed many clear circles (of which I could count about twenty), closely like the nucleated embryonic vesicles often seen in the ovary;—a fact which adds to the inexplicability of the phenomenon:—for they certainly were not visible at first. Another thing was remarkable. The carried "egg" had sensibly become less in bulk, while it retained its perfect form and outline; yet it had not been sucked, for the *Mytilia's* mouth was not, nor had been, in contact with its surface. After three hours, the egg was not more than one-third of its original bulk. Unfortunately no further change occurred during the lapse of a night; the next morning both the animal and the egg were unaltered in appearance, and the former evidently dead. The species seems unusually intolerant of captivity. The abdominal viscera are generally of a rich orange-brown hue, and the whole tissues are more or less suffused with the same colour. (Fig. 21.)

22. *Mytilia producta.* Skin flexible, plicate: body slender, very extensile: eye single, frontal: foot and toes nearly as in *M. Teresa.* Length 1/100 in. Marine.

The lorica, flexible in *M. pœcilops*, is perhaps even more so in this species, and recognizable only at the posterior extremity, where each lateral plate can be traced, as, with a rounded end, it curves under the trunk, to approach its fellow-plate, leaving a narrow ventral cleft. The face is quite truncate, slightly oblique, not abnormally developed. When gliding rapidly along a seaweed, the animal is very worm-like, the body and the foot, about equal in length, forming two successive cylinders,

the latter half as thick as the former. But both, especially the foot, are capable of sudden elongation at will. Thus the creature has a facies which distinguishes it from either of its congeners. Perhaps it comes nearest to *Teresa.* The toes are even broader proportionally; together much exceeding the width of the foot whence they issue. The eye is conspicuous, nearly frontal, but changes its position with the brain. The whole animal is colourless, but very full of folds and corrugations. Very long mucus-glands proceed from the toes through the whole of the foot.

The species first occurred to my observation on the 7th of May, 1887, on very fine seaweeds (*Ceramium*), which I gathered in the deep cup-like pool in limestone rock at Oddicombe Point. I met with about half-a-dozen examples. (Fig. 22.)

23. *Anuræa schista.* Lorica oblong, tapering to a short spine behind; dorsal plate tesselated in polygonal areas on each side of a mesial ridge, and punctured; ventral plate much shorter, produced into a projecting sharp point, divided from the dorsal by a deep cleft. Length 1/162 in., width 1/470 in. Lacustrine.

It has relations with *stipitata* and *cochlearis*; in tesselation agreeing with the latter, and with *tecta.* The anterior spines are straight. It is evidently an approach to *Notholca*, but I do not see the ridges and furrows descending from the spines. The tesselæ are somewhat coarse and ill-defined. The straight short antlers, and the great descending point of the ventral plate, distinguish it at once from every known species. This point is a stiff taper spine: sometimes it projects obliquely (*b*); then, in a moment it is jerked in, so as to be quite hidden, only to be as rapidly thrown out again. Even in a dorsal view it can be clearly seen, through the transparent tissues. I believe I have seen, on two occasions, a discharged egg, carried under the belly, in the manner of *tecta*, &c. The eye is a ball of deep red, of enormous size. A very large contractile vesicle, when full, forces up the other viscera to the middle of the body; when, often, the well-defined contrast between the dark turbid contents of the intestine, and the crystal clearness of the bladder, is curious and striking. The bladder has no effect on the ventral spine, whose movements are manifestly voluntary. (Fig. 23.)

I have seen nearly a score of specimens in water sent by Mr. Bolton from the Botanic Garden, Birmingham. It is a sprightly active swimmer.

24. *Notholca labis.* Almost the very counterpart of *N. scapha*, save that the outline is a longer oval, and the lorica is prolonged into a short, broad, truncate tail behind. Length 1/216 in.; width 1/370 in. Lacustrine.

One of the discoveries of Mr. Hood of Dundee, who finds it numerous in a pool in Emmock Wood, near that city. He has repeatedly sent me specimens, but hitherto all have been dead on arrival. As, however, the internal organization is probably normal, the correctness of the diagnosis and delineation is not lessened by the fact that perfect loricæ are at absolute command. The little tail to the lorica reminds one of the handle of a dust-pan, if so homely an illustration can be tolerated. The ridges and furrows from the frontal spines are almost obliterate. (Fig. 24.)

XIV.—*A Synopsis of the British Recent Foraminifera.*

By Henry B. Brady, F.R.S., F.G.S.

(*Read* 9*th November*, 1887.)

Nearly thirty years have elapsed since the publication of Prof. W. C. Williamson's memoir on the 'Recent Foraminifera of Great Britain'—a work in which the scattered threads of earlier investigation were collected into an orderly skein, and interwoven with the results of a large amount of independent research. Whatever be its imperfections—and, considering the circumstances of the time, they are fewer and less important than might reasonably have been anticipated—that memoir represents fully and adequately the state of knowledge with respect to the organisms of which it treats up to the date of its publication, and practically marks the commencement of the recognition of the recent Foraminifera of the British Islands as a distinct branch of study.

The material to which Prof. Williamson had access consisted chiefly of shore-sands from various parts of the coast, together with a few dredgings obtained by the late Mr. Barlee and the late Mr. Jeffreys from the Shetland Seas, the western shores of Scotland, and one or two points on the south-west coast of England—all from comparatively shallow water. Of recent years, thanks partly to the periodical money-grants of the British Association, partly to the organization of local field-clubs, and most of all to the enthusiasm of amateur naturalists, the area of research has been vastly widened, and at the present time there are few promising portions of our coast that have not been explored more or less by means of the dredge; and our knowledge of every section of the marine invertebrate fauna has been correspondingly enriched.

So far as the Foraminifera are concerned, the additions to the British list have been so numerous as to be bewildering, notwithstanding the efforts that have been made from time to time by means of catalogues, printed privately or otherwise, to keep pace with the record of fresh occurrences. The latest catalogue of this sort, that drawn up by Mr. Siddall in 1879, though complete or approximately so when issued, even now requires an amount of revision that much diminishes its practical value. The recent dredging operations on the south-west of Ireland have added to our list a number of the deep-water species that venture within the limits assigned to the British area; and we seem to have arrived at a point from which we may profitably review our position. Whether the time has yet come for a fresh attempt to treat the subject fully and exhaustively, as was done by Prof. Williamson, may be open to question; but if so, the present paper can in no way prejudice such an effort—indeed it has been intended in some measure as a preliminary step in that direction, the aim having been to collect and sift existing material, and to draw attention to some of the numerous points concerning which our knowledge is defective.

The employment of modern dredging appliances, and the prosecution of researches in deeper water and further from land than was customary a few years ago, have opened a new question, namely,—what is to be understood by the term "British," as applied to the marine fauna and

flora? This subject was raised in the Biolological Section of the British Association at the Birmingham meeting in 1886, and a Committee was appointed to consider it and report. The report, laid before the Manchester meeting (1887), which may be summarized as follows, will probably find general acceptance. It proposes to recognize a "British Marine Shallow-water District," and a "British Atlantic Slope District;" the former bounded to east and south by the half-way line between Great Britain and the continent of Europe, and to the west and north by the 100 fathom line, which corresponds roughly with the beginning of the declivity of the continental plateau; the latter, that is the "British Atlantic Slope District," extending from the 100 fathom line on the north and west coasts to say 1000 fathoms, that is to the commencement of the abyssal floor of the ocean.

These definitions are doubtless intended for general guidance rather than as the embodiment of fixed and absolute rules; and in the following Synopsis, which is otherwise limited to the "Shallow-water District," I have not felt at liberty to exclude the results of some of the recent dredgings on the south-west of Ireland at depths a little exceeding 100 fathoms; still less those of soundings from even deeper water in localities like Loch Fyne, which are geographically within the normal 100 fathom line.

The arrangement and nomenclature of the Synopsis are based upon the 'Report on the Foraminifera of the Challenger Expedition.' Reference is given to the original description of each species and, as far as possible, a further reference to the first record of its occurrence in a British locality, not, however, in the latter case going back further than Williamson's monograph. For synonyms, which have only been given in a few needful cases, the reader may be referred to the 'Challenger' Report.

I have had the advantage of the assistance of my friend Mr. W. Archer, F.R.S., of Dublin, with respect to the Gromidæ. The treatment of the Family, however, must be regarded as purely provisional. Those genera only have been included that are known to possess "reticulated" (as distinct from "lobose" or "filose") pseudopodia.

There are a certain number of species that, at one time or other, have found place in works on the British recent fauna, which are omitted in the present Synopsis. Of these the most important are *Peneroplis planatus* and *Vertebralina striata*, the specimens of which are now known to have been interlopers, due to the use of sieves previously employed for Mediterranean sands, and not properly cleaned; *Cristellaria strigilata* (*C. subarcuatula*, var. *costata*, Will.), *Frondicularia complanata* (*F. spathulata*, Will.), *Frondicularia archiaciana*, and *Nummulites radiata* (*N. planulata*, Will.), which are without doubt "derived" fossils from early Tertiary and Cretaceous strata. Possibly the broken specimen figured by Williamson (Plate ii., fig. 44), referred with reservation by some subsequent authors to *Nodosaria raphanistrum*, also pertains to the same category.

With respect to *Nummulites radiata*, I may say that the late Mr. Jeffreys was kind enough to give me a considerable number of the specimens dredged off Portsmouth, and their fossil condition appears to

admit of no question. I am informed by Prof. Williamson that the Scarborough specimen has been lost, but that it was of precisely similar character. A mounting from the Portsmouth gathering has been placed with the series of British Foraminifera in the British Museum.

There are a few other names that will not be found in their old places, partly owing to needful generic changes; of these the following are the more important:—

Biloculina contraria and *Hauerina compressa*—are now transferred to *Planispirina contraria.*
Reophax moniliforme, is referred to *R. findens.*
Textularia difformis—to *Bolivina difformis.*
Textularia pygmæa—to *Bolivina dilatata.*
Cassidulina pulchella and *Cassidulina oblonga*,—to *C. lævigata* and *C. crassa* respectively.
Lagena jeffreysii—to *L. hispida.*
Lagena lyellii—to *L. sulcata* and *L. costata.*
Nodosaria (*Dent.*) *guttifera*,—referred to *N. pyrula.*
Marginulina lituus—to *Cristellaria elongata.*
Polymorphina orbignii.—Fistulose specimens of *Polymorphina* are associated with the forms to which they respectively belong, and not treated collectively as a single species.
Discorbina obtusa—has been transferred to *D. wrightii.*
Discorbina ochracea—to *Trochammina ochracea.*
Pulvinulina sacculata.—The locality given by Messrs. Parker and Jones for this form—50 miles south-west of Ushant—is outside the British area.

Attention may be directed to certain species and varieties which have been retained in the list, but concerning which considerable uncertainty still exists; namely,—*Valvulina conica, Trochammina macrescens, Tr. plicata, Bathysiphon filiformis, Placopsilina bulla, P. varians, Reophax findens, Ramulina globulifera, Spirillina tuberculata, Nonionina boueana*, and *N. asterizans.* Further observations are still required on these, as well as on a few other forms that need not here be enumerated, to place our knowledge of their characters and distribution on a satisfactory footing.

I have now only to thank most cordially the naturalists who have aided me with notes and suggestions embodied in the following pages. I have already expressed the obligation I am under to Mr. Archer, and my acknowledgments are also due in an especial manner to Messrs. Joseph Wright, F.G.S., of Belfast, F. W. Millett, F.R.M.S., of Marazion, and David Robertson, F.G.S., of Millport, N.B., whose labours in connection with the British marine Rhizopoda are widely known, for much assistance, ever most kindly and freely rendered. To the friendly co-operation of these gentlemen any claim the present Synopsis may have to approximate completeness is largely due.

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1863. Brady, Henry B.—Notes on Foraminifera new to the British Fauna. (Report Brit. Assoc., Newcastle-upon-Tyne Meeting, Trans., pp. 100, 101.)

1864. ——— ——— On the Rhizopodal Fauna of Shetland. (Trans. Linn. Soc. Lond., vol. xxiv. pp. 463–475, pl. xlviii.)

1865. ——— ——— A Catalogue of the Recent Foraminifera of Northumberland and Durham. (Nat. Hist. Trans. Northd. and Durham, vol. i. pp. 83–107, pl. xii.)

1865. Alcock, Dr. T.—Notes on Natural History Specimens lately received from Connemara. (Proc. Lit. and Phil. Soc. Manchester, vol. iv. pp. 192–208.)

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1867. Waller, Edward.—Report on the Foraminifera obtained in the Shetland Seas. (Report Brit. Assoc., Dundee Meeting, pp. 441–446.)

1870. Brady, Henry B.—On Brackish-water Foraminifera. (Ann. and Mag. Nat. Hist., Ser. 3, vol. vi. pp. 273–309, pl. xi., xii.)

1870. ——— ——— Catalogue of British Foraminifera in the Edinburgh Museum of Science and Art.

1870. Archer, William.—On some Freshwater Rhizopoda, new or little-known. (Quart. Journ. Micr. Sci., vol. x. N.S. pp. 101–124;—vol. ix. pl. xx.)

1870. Carter, H. J.—On two New Species of the Foraminiferous Genus *Squamulina*, and on a New Species of *Difflugia*. (Ann. and Mag. Nat. Hist., Ser. 4, vol. v. pp. 309–326, pl. iv., v.)

1874. Robertson, David.—Notes on the Recent Foraminifera and Ostracoda of the Firth of Clyde. (Trans. Geol. Soc., Glasgow, vol. v. pp. 112–154.)

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1885. BALKWILL, F. P., and WRIGHT, JOS.—Report on some recent Foraminifera found off the Coast of Dublin and in the Irish Sea. (Trans. R. Irish Acad., vol. xxviii. [Science] pp. 317–372, pl. xii.–xiv.)

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SUB-KINGDOM—PROTOZOA.

CLASS—**RHIZOPODA.**

ORDER—**Foraminifera (Reticularia).**

Family I. **GROMIDÆ.**

LIEBERKUEHNIA, Claparède and Lachmann.

Lieberkuehnia wageneri, Claparède and Lachmann.

Lieberkuehnia wageneri, Clap. and Lach., 1859, Mém. de l'Institut genevois, vol. vi.;—1868, Études des Infusoires, pt. ii. p. 465, pl. xxiii.

" " Siddall, 1879, Catal. Brit. Rec. Foram., p. 10;—1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl., Appendix, p. 48.

"Colwyn Bay, near Little Orme's Head, on Algæ and Hydrozoa. &c., from low water" (Siddall).

GROMIA, Dujardin.

Gromia oviformis, Dujardin.

Gromia oviformis, Dujardin, 1835, Ann. Sci. Nat., sér. 2, vol. iii. p. 313;—vol. iv. p. 343, pl. ix. fig. 1.

" " Siddall, 1879, Catal. Brit. Rec. Foram., p. 3;—1886, Proc. Lit. and Phil. Soc. Liverpool, vol. xl., Appendix, p. 49.

"Muddy shores around the coast generally" (Siddall).

Gromia dujardinii, Schultze.

Gromia dujardinii, Schultze, 1854, Organ. Polythal., p. 55, pl. vii. figs. 1–7.
„ „ Siddall, 1879, Catal. Brit. Rec. Foram., p. 3;—1886, Proc. Lit. and Phil. Soc. Liverpool, vol. xl., Appendix, p. 49.

"Muddy shores around the coast generally," with the last-named species (Siddall).

MICROGROMIA, R. Hertwig.

Microgromia socialis, Archer.

Gromia socialis, Archer, 1870, Quart. Journ. Micr. Sci., vol. x. N.S. p. 124; vol. ix., pl. xx. figs. 7–11.
Microgromia socialis, Id. 1877, Ibid., vol. xvii. N.S. p. 115; pl. viii. fig. 8.

Glen-ma-lur Valley,—Co. Wicklow, and in some other subalpine districts in Ireland, rare (Archer).

Microgromia mucicola, Archer.

Microgromia mucicola, Archer, 1877, Quart. Journ. Micr. Sci., vol. xvii. N.S. p. 121, pl. viii. fig. 9.

"Nidulates in mucous envelope of certain unicellular Algæ" (Archer).

Microgromia ambigua, Archer.

Microgromia ambigua, Archer, 1881, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 230.

"Only probably belonging to this genus. Not rare in Midland pools, Ireland" (Archer).

DIAPHOROPODON, Archer.

Diaphoropodon mobile, Archer.

Diaphoropodon mobile, Archer, 1870, Quart. Journ. Micr. Sci., vol. x. N.S. p. 123; vol. ix. pl. xx. fig. 6.

Glen-ma-lur Valley,—Co. Wicklow, very rare (Archer).

SHEPHEARDELLA, Siddall.

Shepheardella tæniformis, Siddall.

Shepheardella tæniformis, Siddall, 1880, Quart. Journ. Micr. Sci., vol. xx. N.S. p. 130, pls. xv., xvi.
„ „ Id. 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl., Appendix, p. 49.

"On Hydrozoa dredged in Colwyn Bay. Frequent in spring at Tenby" (Siddall).

Family II. **MILIOLIDÆ.**

Sub-family 1. **Nubecularinæ.**

Squamulina, Schultze.

Squamulina lævis, Schultze.

Squamulina lævis, Schultze, 1854, Organ. der Polythal., p. 56, pl. vi. figs. 16, 17.
„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl., Appendix, p. 50.

"Occurring on the polypidoms of zoophytes round the coast generally" (Siddall).

Nubecularia, Defrance.

Nubecularia lucifuga, Defrance.

Nubecularia lucifuga, Defrance, 1825, Dict. Sci. Nat., vol. xxv. p. 120;—Atlas Zooph., pl. xliv. fig. 3.
„ „ Brady, 1879. Siddall's Catal. Brit. Rec. Foram., p. 10.

Cornwall coast, 60 fathoms; off Guernsey, dredged (Brady); Mouth of the Dee? (Siddall); Mount's Bay (Millett); Kilchattan Bay, Bute, 25 fathoms (Robertson).

Sub-family 2. **Miliolininæ.**

Biloculina, d'Orbigny.

Biloculina irregularis, d'Orbigny.

Biloculina irregularis, d'Orbigny, 1839, Foram. Amér. Mérid., p. 67, pl. viii. figs. 20, 21.

Small specimens, apparently belonging to this form, occur in dredged sands from the Hebrides.

Biloculina sphæra, d'Orbigny.

Biloculina sphæra, d'Orbigny, 1839, Foram. Amér. Mérid., p. 66, pl. viii. figs. 13–16.
„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 1.

Shetland, Hebrides, dredged (Brady); south-west of Ireland, 79 to 200 fathoms (Wright).

Biloculina ringens, Lamarck, sp.

Miliolites ringens, Lamarck, 1804, Ann. du Muséum, vol. v. p. 351, No. 1;—vol. ix. pl. xvii. fig. 1.
Biloculina ringens, Williamson, 1858, Rec. For. Gt. Br., p. 79, pl. vi. figs. 169, 170.

Common all round the coast.

Biloculina depressa, d'Orbigny.

Biloculina depressa, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 298, No. 7 ;—Modèle, No. 91.
„ *ringens*, var. *carinata*, Williamson, 1858, Rec. For. Gt. Br., p. 79, pl. vii. figs. 172–174.

Common everywhere.

Biloculina elongata, d'Orbigny.

Biloculina elongata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 298, No. 4 ;—Soldani, Testac., vol. i. pt. 3, p. 228, pl. cliii. fig. *M*, *Q* ; p. 231, pl. clvi. fig. *v v*.
„ *ringens*, var. *patagonica*, Williamson, 1858, Rec. For. Gt. Br., p. 80, pl. vii. figs. 175–6.

A common shallow-water form, hardly distinguishable varietally from *B. ringens*.

Spiroloculina, d'Orbigny.

Spiroloculina planulata, Lamarck, sp.

Miliolites planulata, Lamarck, 1805, Ann. du Muséum, vol. v. p. 352, No. 4 ;—1822, Anim. s. Vert., vol. vii. p. 613, No. 4.
Spiroloculina depressa, var. *rotundata*, Williamson, 1858, Rec. For. Gt. Br., p. 82, pl. vii. fig. 178.

A common shallow-water form.

Spiroloculina limbata, d'Orbigny.

Spiroloculina limbata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 299, No. 12 ;—Soldani, Testac., vol. ii. p. 54, pl. xix. fig. *m*.
„ *depressa*, Williamson, 1858, Rec. For. Gt. Br., p. 82, pl. vii. fig. 177.

Widely distributed.

Spiroloculina tenuiseptata, Brady.

Spiroloculina tenuiseptata, Brady, 1884, 'Challenger' Report, p. 153, pl. x. figs. 5, 6.

Common in Mr. Wright's dredgings from the south-west of Ireland.

Spiroloculina acutimargo, Brady.

Spiroloculina acutimargo, Brady, 1884, Challenger Report, p. 154, pl. x. figs. 12–15.
„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science), p. 323, woodcut.

Lambay, 45 fathoms, specimens small and poor (Balkwill and Wright) ; Estuary of the Dee (Siddall).

Spiroloculina canaliculata, d'Orbigny.

Spiroloculina canaliculata, d'Orbigny, 1846, For. Foss. Vien., p. 269, pl. xvi. figs. 10–12.

Spiroloculina depressa, var. *cymbium*, Williamson, 1858, Rec. For. Gr. Br., p. 82, pl. vii. fig. 179.

Frequent.

Spiroloculina excavata, d'Orbigny.

Spiroloculina excavata, d'Orbigny, 1846, For. Foss. Vien., p. 271, pl. xvi. figs. 19–21.
" " Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 93, pl. xii. fig. 1.

Widely distributed, but less common than some other species of the genus.

MILIOLINA, Williamson.

Here, as in the 'Challenger' Report, I have retained the generic term *Miliolina* in the sense in which it is employed by Williamson. I do not, I hope, in the least underrate the value and importance of the researches of MM. Munier-Chalmas and Schlumberger on the embryology of the group, but I confess I am unable, in the present state of our knowledge, to see any way to the application of embryological characters to a practical and convenient system of generic nomenclature. So far as I understand, it is admitted that, whilst general rules may be laid down with relation to the embryological differences of certain subordinate groups, the "distinctive" features have a considerable range of variation, and are in fact not much more constant than those more easily recognized external peculiarities which serve as the basis of classification amongst other Foraminifera. We have, however, still much to learn in the matter, and everything to hope from M. Schlumberger's further investigations. Perhaps the difficulty may be eventually solved by the recognition of certain subgeneric types; the d'Orbignyan genus *Adelosina*, for example, represented in the British list by *Miliolina bicornis*, appears to be readily distinguishable, under ordinary circumstances, by external as well as internal characters.

Miliolina trigonula, Lamarck, sp.

Miliolites trigonula, Lamarck, 1804, Ann. du Muséum., vol. v. p. 351 No. 3;—1822, Anim. s. Vert., vol. vii. p. 612, No. 3.
Miliolina trigonula, Williamson, 1858, Rec. For. Gt. Br., p. 84, pl. vii. figs. 180–182.

Generally distributed.

Miliolina tricarinata, d'Orbigny, sp.

Triloculina tricarinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 299, No. 7;—Modèle, No. 94.
" " Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 3.

Shetland (Brady, Waller); Estuary of the Dee (Siddall); Mount's Bay (Millett); various points on the coast of Ireland (Wright, Balkwill and Wright, Balkwill and Millett); west of Scotland (Robertson).

Miliolina insignis, Brady.

Miliolina insignis, Brady, 1884, Challenger Report, p. 165, pl. iv. figs. 8–10.
" " Wright, 1886, Proc. Belfast Nat. Field Club, 1885–6, Appendix, p. 319, pl. xxvi. fig. 4.

Belfast Lough, 60 fathoms (Wright).

Miliolina oblonga, Montagu, sp.

Vermiculum oblongum, Montagu, 1803, Test. Brit., p. 522, pl. xiv. fig. 9.
Miliolina seminulum, var. *oblonga*, Williamson, 1858, Rec. For. Gt. Br., p. 86, pl. vii. 186, 187.

Generally distributed.

Miliolina seminulum, Linné, sp.

Serpula seminulum, Linné, 1767, Syst. Nat., 12th ed., p. 1264, No. 791; —1788, 13th (Gmelin's) ed., p. 3739, No. 2.
Miliolina seminulum, Williamson, 1858, Rec. For. Gt. Br., p. 85, pl. vii. figs. 183–185.

Common on every part of the coast.

Miliolina venusta, Karrer, sp.

Quinqueloculina venusta, Karrer, 1868, Sitzungsb. d. k. Ak. Wiss. Wien, vol. lvii. p. 147, pl. ii. fig. 6.
Miliolina venusta, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Loch Fyne (Robertson); Estuary of the Dee (Siddall).

Miliolina auberiana, d'Orbigny, sp.

Quinqueloculina auberiana, d'Orbigny, 1839, Foram. Cuba, p. 167, pl. xii. figs. 1–3.
Miliolina auberiana, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Douglas Bay and Loch Fyne (Robertson); shore-sand, Galway (Balkwill and Millett); south-west of Ireland? (Wright).

Miliolina sclerotica, Karrer, sp.

Quinqueloculina sclerotica, Karrer, 1868, Sitz. d. k. Akad. Wiss. Wien, vol. lviii. p. 152, pl. iii. fig. 5.
Miliolina sclerotica, Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 24, pl. 1, fig. 2.

Shore-sand, Galway (Balkwill and Millett); Mount's Bay (Millett); generally distributed round the Irish coast (Wright).

Miliolina contorta, d'Orbigny, sp.

Quinqueloculina contorta, d'Orbigny, 1846, For. Foss. Vien., p. 298, pl. xx. figs. 4–6.

Miliolina contorta, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Loch Fyne (Robertson).

It appears probable that the specimens assigned provisionally by Messrs. Balkwill and Millett to *Miliolina sclerotica,* and those referred by Mr. Robertson to *Miliolina contorta,* belong in reality to the same species. Should that be the case the latter name would take precedence.

Miliolina labiosa, d'Orbigny, sp.

Triloculina labiosa, d'Orbigny, 1839, Foram. Cuba, p. 157, pl. x. figs. 12–14.

Miliolina labiosa, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Loch Fyne (Robertson).

Miliolina subrotunda, Montagu, sp.

Vermiculum subrotundum, Montagu, 1803, Test. Brit., pt. 2, p. 521.

Quinqueloculina subrotunda, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 94, pl. xii. fig. 2.

A very common littoral and shallow-water form.

Miliolina candeiana, d'Orbigny, sp.

Quinqueloculina candeiana, d'Orbigny, 1839, Foram. Cuba, p. 170, pl. xii. figs. 24–26.

" " Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 286, pl. xi. fig. 1.

Brackish water, River Cam (Brady); Estuary of the Dee (Siddall); Mount's Bay (Millett).

Miliolina secans, d'Orbigny, sp.

Quinqueloculina secans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 303, No. 43;—Modèle, No. 96.

Miliolina seminulum, var. *disciformis,* Williamson, 1858, Rec. For. Gt. Br., p. 86, pl. vii. figs. 188, 189.

Generally distributed, but much less common than the last-named species.

Miliolina tenuis, Czjzek, sp.

Quinqueloculina tenuis, Czjzek, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 149, pl. xiii. figs. 31–34.

Miliolina tenuis, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 46.

Estuary of the Dee (Siddall); Irish Sea, not uncommon (Balkwill and Wright); Mount's Bay (Millett); south-west of Ireland (Wright); Portree, Skye (Robertson).

The characters of this, and in a less degree of the last-named species, are somewhat ambiguous, and there may be some doubt whether such forms are better placed amongst *Miliolinæ* or *Spiroloculinæ.*

Miliolina ferussacii, d'Orbigny, sp.

Quinqueloculina ferussacii, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 301, No. 18;—Modèle, No. 32.
Miliolina bicornis, var. *angulata*, Williamson, 1858, Rec. For. Gt. Br., p. 88, pl. vii. fig. 196.

By no means common, though widely distributed.

Miliolina bicornis, Walker and Jacob, sp.

Serpula bicornis, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 633, pl. xiv. fig. 2.
Miliolina bicornis, Williamson, 1858, Rec. For. Gt. Br., p. 87, pl. vii. figs. 190–192.

Not uncommon in shallow dredgings.

Miliolina boueana, d'Orbigny, sp.

Quinqueloculina boueana, d'Orbigny, 1846, For. Foss. Vien., p. 293, pl. xix. figs. 7–9.
Miliolina boueana, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 51.

If it be needful to recognize by name the comparatively finely striate forms of *Miliolina* which have not retort-shaped segments, as distinct from those that have, *Quinqueloculina boueana* is perhaps the most convenient type to accept; better, I think, than *Triloculina brongniartiana*, d'Orb.

Of their distribution (apart from *M. bicornis*) we have little reliable information.

Miliolina pulchella, d'Orbigny, sp.

Quinqueloculina pulchella, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 303, No. 42;—Soldani, 1798, Testac., vol. ii. p. 53, pl. xviii. fig. *f*.
„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 4.

In dredgings at depths of thirty or forty fathoms or more at various points on the coast; somewhat rare.

Miliolina fusca, Brady.

Quinqueloculina fusca, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 286, pl. xi. fig. 2.

Common in estuaries and brackish-water pools.

Miliolina agglutinans, d'Orbigny, sp.

Quinqueloculina agglutinans, d'Orbigny, 1839, Foram. Cuba, p. 168, pl. xii. figs. 11–13.
„ „ Brady, 1870, Edinburgh Catalogue, p. 2.

The first British specimens assigned to this species were subchitinous forms from brackish water, subsequently described under a distinct name,

Quinqueloculina fusca. Somewhat later, however, the typical *M. agglutinans* was found in dredgings from the Hebrides, and it has since been obtained on the Atlantic shores of Ireland by Mr. Wright, and in the Estuary of the Dee by Mr. Siddall.

Miliolina spiculifera, Siddall.

Miliolina spiculifera, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 51, pl. i. fig. 3.

"A single example only from the Estuary of the Dee" (Siddall).

Sub-family 3. **Haueríninæ.**

OPHTHALMIDIUM, Kübler.

Ophthalmidium inconstans, Brady.

Hauerina inconstans, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 54.

Ophthalmidium inconstans, Id. 1884, Challenger Report, p. 189, pl. xii. figs. 5, 7, 8.

„ *carinatum,* Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science), p. 326, pl. xii. figs. 13–16.

The specimens figured by Messrs. Balkwill and Wright, under the name *O. carinatum,* do not appear to me to differ in any important particular from *O. inconstans.* It is true they are much smaller than even the small examples of the latter species obtained from oceanic dredgings, but this is sufficiently accounted for by depth and local conditions. Obtained also by Mr. Wright on the south-west of Ireland, 26 fathoms; and by Mr. Siddall in the Estuary of the Dee.

PLANISPIRINA, Seguenza.

Planispirina contraria, d'Orbigny, sp.

Biloculina contraria, d'Orbigny, 1846, For. Foss. Vien., p. 266, pl. xvi. figs. 4–6.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 2.

Very rare; occurs in dredgings off Shetland, 40 to 100 fathoms; and in Loch Scavaig, 45 to 60 fathoms (Brady); also on the south-west of Ireland (Brady, Wright).

Planispirina celata, Costa, sp.

Spiroloculina celata, Costa, 1855, Mem. Accad. Napoli, vol. ii. p. 126, pl. i. fig. 14;—1856, Atti dell' Accad. Pont., vol. vii. pl. xxvi. fig. 5.

Planispirina celata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 608.

Loch Scavaig, 45 to 60 fathoms (Brady); Portree Bay, Skye (Robertson); south-west of Ireland, 48 to 120 fathoms (Wright).

Sub-family 4. **Peneroplidinæ.**

Cornuspira, Schultze.

Cornuspira foliacea, Philippi, sp.

Orbis foliaceus, Philippi, 1844, Enum. Moll. Sicil., vol. ii. p. 147, pl. xxiv. fig. 26.
Spirillina foliacea, Williamson, 1858, Rec. For. Gt. Brit., p. 91, pl. vii. figs. 199–201.
Generally distributed.

Cornuspira involvens, Reuss.

Operculina involvens, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 370, pl. xlv. fig. 20.
Cornuspira involvens, Siddall, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 42.
Comparatively common; occurs in shallower water than its congener *C. foliacea*, preferring muddy bottoms.

Cornuspira carinata, Costa, sp.

Operculina carinata, Costa, 1856, Atti dell' Accad. Pont., vol. vii. p. 209, pl. xvii. fig. 15.
Cornuspira carinata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 608.
South-west of Ireland, 79 to 120 fathoms, rare (Wright).

Family III. **ASTRORHIZIDÆ.**

Sub-family 1. **Astrorhizinæ.**

Astrorhiza, Sandahl.

Astrorhiza limicola, Sandahl.

Astrorhiza limicola, Sandahl, 1857, Ofvers. af Kongl. Vetenskaps-Akad. Förhandl., vol. xiv. p. 299, pl. iii. figs. 5, 6.
„ „ Brady, 1879, in Siddall's Cat. Brit. Rec. For., p. 10.
At various points on the English and Scotch coast, at depths of 10 to 70 fathoms.

Pelosina, Brady.

Pelosina variabilis, Brady.

Pelosina variabilis, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 30, pl. iii. figs. 1–3.
„ „ Robertson, 1881, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 163.
Cumbrae, Frith of Clyde (Robertson).

Dendrophrya, Str. Wright.[1]

Dendrophrya radiata, Str. Wright.

Dendrophrya radiata, Wright, 1861, Ann. and Mag. Nat. Hist., ser. 3, vol. viii. p. 122.

Dendrophrya radiata, Brady, 1884, Challenger Report, p. 238, pl. xxvii A. figs. 10–12.

Old Granton Quarries, near Edinburgh (Str. Wright); low-tide pools, Cumbrae, Firth of Clyde (Robertson); "quite common along the N. Wales coast" (Siddall).

Dendrophrya erecta, Str. Wright.

Dendrophrya erecta, Wright, 1861, Ann. and Mag. Nat. Hist., ser. 3, vol. viii. p. 122, pl. iv. figs. 4, 5.

" " Brady, 1884, Challenger Report, p. 239, pl. xxvii A., figs. 7–9.

Distribution the same as that of the last-named species, from which, indeed, it seems scarcely separable.

Sub-family 2. **Pilulininæ.**

Technitella, Norman.

Technitella melo, Norman.

Technitella melo, Norman, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 280, pl. xvi. figs. 5, 6.

" " Robertson, 1881, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 107.

Dredged off Oban (Robertson).

Technitella legumen, Norman.

Technitella legumen, Norman, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 279, pl. xvi. figs. 3, 4.

" " Brady, 1884, Challenger Report, p. 246, pl. xxv. figs. 8–12.

Off Cumbrae, 60 to 65 fathoms; Loch Fyne, 160 fathoms (Robertson); off Isle of Man, 75 fathoms (Elcock); estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); south-west of Ireland, 112 fathoms (Norman).

Bathysiphon, Sars.

Bathysiphon filiformis, Sars.

Bathysiphon filiformis (M. Sars, MS.), G. O. Sars, 1871, Vidensk.-Selsk. Forhandl., 1871, p. 251.

" " Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 608.

South-west of Ireland, 79 fathoms and 110 fathoms (Wright).

Careful examination of Mr. Wright's specimens leaves me in considerable doubt whether they belong to this species or indeed to this genus. They are exceedingly minute, and appear to be made of sponge spicules, but the test is relatively thinner and firmer than I should expect to find in the *Pilulininæ.*

Sub-family 3. **Saccammininæ.**

Psammosphæra, Schulze.

Psammosphæra fusca, Schulze.

Psammosphæra fusca, Schulze, 1874, II. Jahresberichte d. Komm. Unters. d. deutsch. Meere in Kiel, p. 113, pl. ii. fig. 8.
„ „ Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 27, pl. iv. figs. 1, 2.

Loch Scavaig, 45 to 60 fathoms (Brady); Portree Bay, Skye; off Cumbrae, 60 fathoms (Robertson); Lambay Deep (Balkwill and Wright); south-west of Ireland, 48 to 110 fathoms (Wright); doubtful specimens from the estuary of the Dee (Siddall).

Sub-family 4. **Rhabdammininæ.**

Jaculella, Brady.

Jaculella acuta, Brady.

Jaculella acuta, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 35, pl. iii. figs. 12, 13.
„ „ Siddall, 1879, Cat. Brit. Rec. Foram., p. 4.

St. Magnus Bay, Shetland, 60 fathoms (Norman); off Cumbrae, 60 fathoms (Robertson); off Belfast Lough, 50 to 60 fathoms (Wright).

Hyperammina, Brady.

Hyperammina elongata, Brady.

Hyperammina elongata (pars), Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, pl. xx. fig. 2.
„ „ Robertson, 1880–81, Proc. Nat. Hist. Soc. Glasgow, vol. v. pp. 12, 163.

Off Cumbrae, and off Portree Harbour, dredged (Robertson); estuary of the Dee, very rare (Siddall); Lambay, 45 to 50 fathoms, abundant; and at a few other places in the Irish Sea (Balkwill and Wright); between Belfast Lough and Portpatrick, 100 fathoms, and south-west of Ireland, 79 to 110 fathoms (Wright).

Hyperammina arborescens, Norman, sp.

Psammatodendron arborescens (Norman MS.), Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 98, No. 13;—Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 404.
Hyperammina arbuscula, Robertson, 1881, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 163.
„ *arborescens*, Brady, 1884, Challenger Report, p. 262, pl. xxviii. figs. 12, 13, woodcut, fig. 10.

Dredged between Cumbrae and Bute, 50 fathoms; very common in the Frith of Clyde from 20 to 70 fathoms (Robertson); between Belfast Lough and Portpatrick, 30 to 60 fathoms (Wright).

HALIPHYSEMA, Bowerbank.

Haliphysema tumanowiczii, Bowerbank.

Haliphysema tumanowiczii, Bowerbank, 1862, Phil. Trans., p. 1105, pl. lxxiii. fig. 3.
Squamulina scopula, Carter, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. v. p. 310, pl. iv.

Off Hastings (Tumanowicz); Berwick Bay (Johnstone); Cullercoats? (Alder); Torbay (Parfitt); Budleigh Salterton (Carter); Mount's Bay (Millett); Colwyn Bay (Siddall); Dublin Bay (Haddon); Jersey (Kent).

Haliphysema ramulosum, Bowerbank.

Haliphysema ramulosa, Bowerbank, 1864–1866, Monogr. Brit. Spong., vol. ii. p. 79;—vol. iii. pl. xiii. fig. 1.
Squamulina scopula, "branched variety," Carter, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 345.

Budleigh Salterton, between tides (Carter); Roundstone Bay, Ireland, on seaweed in shallow water; Guernsey, 15 fathoms (Norman); Cumbrae, low-water, rare (Robertson).

Family IV. **LITUOLIDÆ.**

Sub-family 1. **Lituolinæ.**

REOPHAX, Montfort.

Reophax difflugiformis, Brady.

Reophax difflugiformis, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S., p. 51, pl. iv. fig. 3 *a b*.
" " Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

Portree Bay, Skye, 14 to 18 fathoms (Robertson); Mount's Bay, Cornwall (Millett).

Reophax fusiformis, Williamson, sp.

Proteonina fusiformis, Williamson, 1858, Rec. For. Gt. Br., p. 1, pl. i. fig. 1.

Spread over a wide area, especially abundant on the west coast of Scotland.

Reophax scorpiurus, Montfort.

Reophax scorpiurus, Montfort, 1808, Conchyl. Systém., vol. i. p. 330, 83^{e} genre.
Lituola scorpiurus, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 467, pl. xlviii. fig. 5.

In dredged material from almost all parts of the coast.

Reophax nodulosa, Brady.

Reophax nodulosa, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 52, pl. iv. figs. 7, 8.

Reophax nodulosa, Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

Frith of Clyde, and Portree Bay, Skye, 14 to 18 fathoms (Robertson); estuary of the Dee (Siddall).

Reophax findens, Parker, sp.

Lituola findens, Parker, 1870 (in Dawson's paper), Canad. Nat., vol. v. N.S. p. 177; p. 180, fig. 1.

" " Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 47.

Reophax moniliforme, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 54, pl. i. fig. 2.

Estuary of the Dee (Siddall).

Considerable uncertainty appears to attend this somewhat anomalous species. Moniliform specimens, nearly always fragmentary, but as far as they go corresponding closely with Dr. G. M. Dawson's figures, are not uncommon in shallow dredgings from many parts of our coast. Some of these were supposed at first to be broken specimens of *Bigenerina digitata*, and were described as such by myself; but this explanation is now quite untenable. Mr. Wright's suggestion that they are portions of a sessile organism has much in its favour.

In places where *Reophax findens* abounds, as in Gaspé Bay, simple as well as branched examples are met with. Dr. Dawson, *loc. cit.*, gives three figures; the first of which represents a single moniliform series of segments, the second a specimen bifid for about half its length, whilst the third is trifid. So far as can be judged from Mr. Siddall's drawing there seem to be no characters by which his *Reophax moniliforme* can be distinguished from the first of these.

Haplophragmium, Reuss.

Haplophragmium pseudospirale, Williamson, sp.

Proteonina pseudospiralis, Williamson, 1858, Rec. For. Gt. Brit., p. 2, pl. i. figs. 2, 3.

Haplophragmium pseudospirale, Siddall, 1879, Cat. Brit. Rec. For., p. 4.

Common on the west coast of Scotland at 30 to 60 fathoms, also on the west and south-west of Ireland, 90 to 370 fathoms. Balkwill and Wright record its occurrence at Lambay, 45 to 50 fathoms, and at two points in the Irish Sea.

Haplophragmium agglutinans, d'Orbigny, sp.

Spirolina agglutinans, d'Orbigny, 1846, For. Foss. Vien., p. 137, pl. vii. figs. 10–12.

Haplophragmium agglutinans, Brady, 1884, Challenger Report, p. 301, pl. xxxii. figs. 19–26.

Isle of Wight, littoral (Millett); East Solent, 8 fathoms (Brady); Irish Sea, 17 fathoms and 50 fathoms (Balkwill and Wright).

Haplophragmium canariense, d'Orbigny, sp.

Nonionina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. ii. figs. 33, 34.

Nonionina jeffreysii, Williamson, 1858, Rec. For. Gt. Br., p. 34, pl. iii. figs. 72, 73.

Common on muddy bottom all round the coast.

Haplophragmium globigeriniforme, Parker and Jones, sp.

Lituola nautiloidea, var. *globigeriniformis*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 407, pl. xv. figs. 46, 47, &c.

„ *globigeriniformis*, Wright, 1877, Proc. Belfast Nat. Field Club, 1876–77, Appendix, p. 103.

Various points on the Irish coast (Wright); Estuary of the Dee (Siddall).

Haplophragmium glomeratum, Brady.

Lituola glomerata, Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, pl. xx. fig. 1.

Haplophragmium glomeratum, Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

This is probably not an uncommon form on muddy bottoms, but may be easily overlooked by reason of its minute size and inconspicuous characters. As a British species it was first noticed by Mr. Robertson in Portree Bay, Skye; subsequently by Mr. Wright in Killybegs Harbour, Donegal; and by Messrs. Balkwill and Wright at several points in the Irish Sea.

PLACOPSILINA, d'Orbigny.

Placopsilina cenomana, d'Orbigny.

Placopsilina cenomana, d'Orbigny, 1850, Prodr. Paléont., vol. ii. p. 185, No. 758.

„ „ Wright, 1886, Proc. Belfast Nat. Field Club, 1885–6, Appendix, p. 320, pl. xxvi. fig. 3.

Rockport, between tides (Malcomson); south-west of Ireland, 110 and 120 fathoms (Wright); Cumbrae, low-water (Robertson).

Placopsilina bulla, Brady.

Placopsilina bulla, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 51.

„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 54.

Doubtful specimens from the estuary of the Dee (Siddall).

Placopsilina varians, Carter, sp.

Squamulina varians, Carter, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. v. p. 321, pl. v. figs. 1–5.

Placopsilina kingsleyi, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 54, pl. i. fig. 1.

I am not prepared to say what is the precise position and relationship of this organism; but I believe Mr. Siddall's specimens to belong to the species described many years ago by Mr. Carter under the name *Squamulina varians*, and treated by him as a near ally of *Haliphysema*

tumanowiczii, with which it is often found associated. Mr. Carter's specimens were from Budleigh Salterton; Mr. Siddall's from the estuary of the Dee.

Sub-family 2. **Trochammininæ.**

THURAMMINA, Brady.

Thurammina papillata, Brady.

Thurammina papillata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 45, pl. v. figs. 4–8.
„ „ Id. 1884, Challenger Report, p. 321, pl. xxxvi. figs. 7–18.

Loch Scavaig, 45 to 60 fathoms (Brady); south-west of Ireland, 38 to 110 fathoms (Wright).

AMMODISCUS, Reuss.

Ammodiscus incertus, d'Orbigny, sp.

Operculina incerta, d'Orbigny, 1839, Foram. Cuba, p. 71, pl. vi. figs. 16, 17.
Spirillina arenacea, Williamson, 1858, Rec. For. Gt. Br., p. 93, pl. vii. fig. 203.

Sparsely scattered all round the coast.

Ammodiscus gordialis, Jones and Parker, sp.

Trochammina squamata gordialis, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.
„ *gordialis*, Robertson, 1874, Trans. Geol. Soc. Glasgow, vol. v. pt. 1, p. 143.

Found with *A. incertus*, but comparatively rare.

Ammodiscus charoides, Jones and Parker, sp.

Trochammina squamata charoides, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.
„ *charoides*, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 47.

Estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright); Loch Fyne, 105 fathoms (Robertson).

Ammodiscus shoneanus, Siddall.

Trochammina shoneana, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 46, woodcuts 1, 2.

Estuary of the Dee (Siddall); Rockport, Belfast Lough (Malcomson); off Dublin (Wright); Cumbrae, and Loch Fyne (Robertson).

TROCHAMMINA, Parker and Jones.

Trochammina squamata, Jones and Parker.

Trochammina squamata, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Trochammina squamata, Brady, 1884, Challenger Report, p. 337, pl. xli. fig. 3.

Concerning the distribution of this form, as distinct from *Trochammina ochracea* on the one hand and *Valvulina fusca* on the other, we have but little reliable information.

Trochammina ochracea, Williamson, sp.

Rotalina ochracea, Williamson, 1858, Rec. For. Gt. Br., p. 55, pl. iv. fig. 112, pl. v. fig. 113.

Discorbina turbo, var. *ochracea*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.

Shetland (Williamson); shore-sand Galway (Balkwill and Millett); Mount's Bay (Millett); generally distributed round the Irish coast, but the number of specimens small (Wright).

Trochammina plicata, Terquem, sp.

Patellina plicata, Terquem, 1876, Anim. sur la Plage de Dunkerque, 2me fasc., p. 72, pl. viii. fig. 9.

Trochammina plicata, Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 26, pl. ii. fig. 8.

Shore-sand Galway (Balkwill and Millett); Mount's Bay, Cornwall (Millett).

Trochammina inflata, Montagu, sp.

Nautilus inflatus, Montagu, 1808, Test. Brit., Suppl., p. 81, pl. xviii. fig. 3.

Rotalina inflata, Williamson, 1858, Rec. For. Gt. Br., p. 50, pl. iv. figs. 93, 94.

Rarely met with except in brackish water.

Trochammina inflata, var. *macrescens*, Brady.

Trochammina inflata, var. *macrescens*, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 290, pl. xi. fig. 5.

In brackish pools.

I have great doubt as to the propriety of retaining this form under a distinct name. The examination of a considerable series of specimens suggests that it represents only the depauperated condition of *Trochammina inflata*;—in other words, that when *Trochammina inflata* lives in pools, the water of which contains a very small proportion of mineral constituents, the test loses its firm shelly consistence and becomes little more than a chitinous envelope, so thin that the inflated contour of the segments is lost when the specimens are taken out of fluid and dried.

Trochammina nitida, Brady.

Trochammina nitida, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 52; 1884, Challenger Report, p. 339, pl. xli. figs. 5, 6.

Trochammina nitida, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science), p. 609.

South-west of Ireland, 40 to 110 fathoms, rather rare (Wright); estuary of the Dee, rather rare (Siddall).

Trochammina trullissata, Brady.

Trochammina trullissata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 56, pl. v. figs. 10, 11.

„ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 609.

South-west of Ireland, 54 to 110 fathoms (Wright).

Trochammina robertsoni, n. sp.

Test free, planospiral, involute; discoidal, or compressed, nearly symmetrical bilaterally, more or less excavated at the umbilicus; peripheral edge rounded, lobulate; each convolution completely or almost completely enclosing that preceding it; segments somewhat inflated, usually five (four to six) in the outermost whorl: colour rich light brown, texture very finely arenaceous, surface polished. Diameter about $\frac{1}{100}$th inch (0·25 millim.).

This prettly little *Trochammina* has long been familiar to those who have been in the habit of examining dredged material from the west coast of Scotland. I have before me drawings made nearly twenty years ago from Hebrides specimens, and it has since been repeatedly brought under my notice by the Rev. Dr. Norman and Mr. Robertson. It is very distinct from any of its congeners, and I have ventured to associate with it the name of my indefatigable friend who has done so much to elucidate the marine invertebrata of the Clyde region. The species is not uncommon in deepish water on the west of Scotland, and it occurs also in Mr. Wright's dredgings from the south-west of Ireland. I have placed a mounting of it, under its present name, in the British collection at the British Museum.

Webbina, d'Orbigny.

Webbina hemisphærica, Jones, Parker, and Brady.

Webbina hemisphærica, Jones, Parker, and Brady, 1866, Monogr. Crag Foram., p. 27, pl. iv. fig. 5.

„ „ Robertson, 1875, Report Brit. Ass., Bristol Meeting, p. 189.

Coast of Durham, 25 to 33 fathoms (Robertson).

Webbina clavata, Jones and Parker.

Trochammina irregularis clavata, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Webbina clavata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science), p. 609.

South-west of Ireland, rare at 100 and 120 fathoms (Wright).

Family V. TEXTULARIDÆ.

Sub-family 1. Textularinæ.

TEXTULARIA, Defrance.

Textularia sagittula, Defrance.

Textularia sagittula, Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177; vol. liii. p. 344;—Atlas Conch., pl. xiii. fig. 5.
„ *cuneiformis* (*typica*)? Williamson, 1858, Rec. For. Gt. Br., p. 75, pl. vi. figs. 158, 159.

A common littoral and shallow-water form.

Textularia trochus, d'Orbigny.

Textularia trochus, d'Orbigny, 1840, Mem. Soc. Géol. France, vol. iv. p. 45, pl. iv. figs. 25, 26.
„ *cuneiformis*, var. *conica*, Williamson, 1858, Rec. For. Gt. Br., p. 75, pl. vi. figs. 160, 161.

Common.

Textularia agglutinans, d'Orbigny.

Textularia agglutinans, d'Orbigny, 1839, Foram. Cuba, p. 136, pl. i. figs. 17, 18, 32–34.
„ „ Siddall, 1879, Catal. Brit. Rec. Foram., p. 8.

Generally distributed.

Textularia agglutinans, var. *porrecta*, Brady.

Textularia agglutinans, var. *porrecta*, Brady, 1884, Challenger Report, p. 364, pl. liii. fig. 4.
„ „ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 65.

Mr. Siddall reports this variety from the estuary of the Dee.

Textularia gramen, d'Orbigny.

Textularia gramen, d'Orbigny, 1846, For. Foss. Vien., p. 248, pl. xv. figs. 4–6.
„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 332, pl. xiii. figs. 13, 14.

Frequent in the Irish Sea (Balkwill and Wright); and off south-west of Ireland (Wright); shore-sand, Galway (Balkwill and Millett); Mount's Bay, Cornwall (Millett).

Textularia concava, Karrer, sp.

Plecanium concavum, Karrer, 1868, Sitzungsb. d. k. Akad. Wiss. Wien, vol. lviii. p. 129, pl. i. fig. 3.
Textularia concava, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 609.

South-west of Ireland; 40 fathoms, downwards; abundant at 79 fathoms and 110 fathoms (Wright).

Textularia globulosa, Ehrenberg.

Textularia globulosa, Ehrenberg, 1839, Abhandl. Akad. Berlin (1838) p. 135, No. 60, pl. iv. several figures.
" " Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 300, pl. xii. fig. 4.

Westport, brackish water (Brady); off Dublin (Balkwill and Wright).

Textularia variabilis, Williamson.

Textularia variabilis (*typica*), Williamson, 1858, Rec. For. Gt. Brit., p. 76, pl. vi. figs. 162, 163.

Widely distributed.

Probably this, like many other of Williamson's *Textulariæ*, will eventually be transferred to the genus *Bolivina*.

Bigenerina, d'Orbigny.

Bigenerina digitata, d'Orbigny.

Bigenerina (*Gemmulina*) *digitata*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 262, No. 4;—Modèle, No. 58.
" *digitata*, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 468, pl. xlviii. fig. 8.

Shetland, Hebrides, estuary of the Dee, and at various points to the west and south-west of Ireland.

Bigenerina nodosaria, d'Orbigny.

Bigenerina nodosaria, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 261, No. 1, pl. xi., figs. 9–12;—Modèle, No. 57.
" " Waller, 1867, Report Brit. Assoc., Dundee Meeting, p. 445.

Shetland (Waller, Brady); south-west of Ireland (Wright).

Spiroplecta, Ehrenberg.

Spiroplecta rosula, Ehrenberg.

Spiroplecta rosula, Ehrenberg, 1854, Mikrogeologie, pl. xxxii, II. fig. 26.
Textularia complexa, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 101, pl. xii. fig. 6.

Northumberland and Durham coast, very rare.

Spiroplecta biformis, Parker and Jones, sp.

Textularia agglutinans, var. *biformis*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 370, pl. xv. figs. 23, 24.
Spiroplecta biformis, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 333, pl. xiii. fig. 21, and woodcut.

Belfast Lough (Malcomson); Dublin coast (Balkwill and Wright).

Gaudryina, d'Orbigny.

Gaudryina scabra, Brady.

Gaudryina pupoides, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 300, pl. xii. fig. 5.

Gaudryina scabra, Id., 1884, Challenger Report, p. 381, pl. xlvi. fig. 7.

Montrose Basin, very rare.

It may here be mentioned that in Mr. Wright's cabinet there are small specimens of the typical *Gaudryina pupoides*, d'Orb., from 110, 160, and 200 fathoms respectively, on the south-west of Ireland.

Gaudryina filiformis, Berthelin.

Gaudryina filiformis, Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 25, pl. i. fig. 8.
" " Wright, 1882, Proc. Belfast Nat. Field Club (1880–1), Appendix, p. 180, pl. viii. fig. 3, 3 *a*, *b*.

Killybegs Harbour, 17 fathoms, and south-west of Ireland (Wright); Dublin coast, rather rare (Balkwill and Wright); Galway (Balkwill and Millett); west of Scotland (Robertson); Mount's Bay, Cornwall (Millett).

VERNEUILINA, d'Orbigny.

Verneuilina polystropha, Reuss, sp.

Bulimina polystropha, Reuss, 1845, Verstein. Böhm. Kreid., pt. ii. p. 109, pl. xxiv. fig. 53.
" *scabra*, Williamson, 1858, Rec. For. Gt. Brit., p. 65, pl. v. figs. 136, 137.
" *arenacea*, Id., Ibid., p. 98.

Generally distributed.

Verneuilina spinulosa, Reuss.

Verneuilina spinulosa, Reuss, 1849, Denkschr. d. k. Ak. Wiss. Wien, vol. i. p. 374, pl. xlvii. fig. 12.
" " Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 301, pl. xii. fig. 6.

Westport, Ireland (Brady); Dublin coast (Balkwill and Wright); estuary of the Dee (Siddall).

VALVULINA, d'Orbigny.

Valvulina fusca, Williamson, sp.

Rotalina fusca, Williamson, 1858, Rec. For. Gt. Brit., p. 55, pl. v. figs. 114, 115.
Valvulina triangularis, var. *austriaca*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.

Found on almost all parts of the coast.

Valvulina conica, Parker and Jones.

Valvulina triangularis, var. *conica*, Parker and Jones, 1865, Phil. Trans. vol. clv. p. 406, pl. xv. fig. 27.
" *conica*, Brady, 1870, Edinburgh Catalogue, p. 3.

The only British specimens of this species I have seen were from Shetland and the Hebrides, and were doubtfully separable from *V. fusca*. Somewhat further north, and in deeper water, it is not very rare.

Sub-family 2. **Bulimininæ.**

Bulimina, d'Orbigny.

Bulimina pupoides, d'Orbigny.

Bulimina pupoides, d'Orbigny, 1846, For. Foss. Vien., p. 185, pl. xi. figs. 11, 12.
„ „ Williamson, 1858, Rec. For. Gt. Brit., p. 62, pl. v. figs. 124, 125.

Bulimina ovata, d'Orbigny.

Bulimina ovata, d'Orbigny, 1846, For. Foss. Vien., p. 185, pl. xi. figs. 13, 14.
„ „ Brady, 1884, Challenger Report, p. 400, pl. l. fig. 13.

As I have elsewhere stated (Challenger Report, p. 400), *Bulimina pupoides* and *B. ovata* (and it may be added *B. affinis*) "cannot be separated except by comparative characters too variable to be of any real zoological value." I see no advantage in referring Williamson's *B. pupoides* var. *fusiformis* to *B. ovata*, as proposed by Parker and Jones; indeed it seems to be a fairly distinct form more nearly allied to *B. pupoides*. *B. ovata* stands about midway between *B. pupoides* and *B. pyrula*.

These *Buliminæ* are common all round the coast. Typical specimens of *B. ovata* are very abundant in some of Mr. Wright's material from the south-west of Ireland.

Bulimina fusiformis, Williamson.

Bulimina pupoides, var. *fusiformis*, Williamson, 1858, Rec. For. Gt. Br., p. 63, pl. v. figs. 129, 130.
„ *presli*, var. *ovata*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.

Generally distributed.

Bulimina pyrula, d'Orbigny.

Bulimina pyrula, d'Orbigny, 1846, For. Foss. Vien., p. 184, pl. xi. figs. 9, 10.

South-west of Ireland; small specimens, fairly typical, at 40 fathoms, larger examples at 160 and 200 fathoms (Wright).

Bulimina marginata, d'Orbigny.

Bulimina marginata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 4, pl. xii. figs. 10–12.
„ *pupoides*, var. *marginata*, Williamson, 1858, Rec. For. Gt. Br., p. 62, pl. v. figs. 126, 127.

Common.

Bulimina aculeata, d'Orbigny.

Bulimina aculeata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 7;—Soldani, Testaceographia, vol. i. pt. 2, p. 118, pl. cxxvii. fig. *I*; pl. cxxx. fig. *v v*.

Bulimina pupoides, var. *spinulosa*, Williamson, 1858, Rec. For. Gt. Br., p. 62, pl. v. fig. 128.

Widely distributed but not so common as the last-named species, from which it is often with difficulty separable.

Bulimina convoluta, Williamson.

Bulimina pupoides, var. *convoluta*, Williamson, 1858, Rec. For. Gt. Br., p. 63, pl. v. figs. 132, 133.

Shetland, Skye (Williamson); an exceedingly rare form.

Bulimina subteres, Brady.

Bulimina presli, var. *elegantissima*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 374, pl. xv. figs. 12–17.

„ *subteres*, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 55.

Shetland, west coast of Scotland, Irish Sea, north and west coasts of Ireland, and elsewhere.

Bulimina elegans, d'Orbigny.

Bulimina elegans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 270, No. 10;—Modèle, No. 9.

„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 55.

Estuary of the Dee (Siddall); south-west of Ireland (Wright).

Bulimina elegantissima, d'Orbigny.

Bulimina elegantissima, d'Orbigny, 1839, Foram. Amér. Mérid., p. 51, pl. vii. figs. 13, 14.

„ „ Williamson, 1858, Rec. For. Gt. Brit., p. 64, pl. v. figs. 134, 135.

Sparsely distributed all round the coast.

Bulimina squamigera, d'Orbigny.

Bulimina squamigera, d'Orbigny, 1839, Foram. Canaries, p. 137, pl. i. figs. 22–24.

„ „ Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 49.

Estuary of the Dee (Siddall).

Virgulina, d'Orbigny.

Virgulina schreibersiana, Czjzek.

Virgulina schreibersiana, Czjzek, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 147, pl. xiii. figs. 18–21.

Bulimina pupoides, var. *compressa*, Williamson, 1858, Rec. For. Gt. Br., p. 63, pl. v. fig. 131.

Generally distributed.

BOLIVINA, d'Orbigny.

Bolivina punctata, d'Orbigny.

Bolivina punctata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 63, pl. viii. figs. 10–12.
" " Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 468, pl. xlviii. fig. 9.

Generally distributed.

Bolivina plicata, d'Orbigny.

Bolivina plicata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 62, pl. viii. figs. 4–7.
" " Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 302, pl. xii. fig. 7.

Found sparingly at a considerable number of localities, often in brackish water.

Bulimina buchiana, d'Orbigny.

Bulimina buchiana, d'Orbigny, 1846, For. Foss. Vien., p. 186, pl. xi. figs. 15–18.
" " Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 610.

South-west of Ireland, 48 to 120 fathoms (Wright).

Bolivina costata, d'Orbigny.

Bolivina costata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 62, pl. viii. figs. 8, 9.
" " Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 302.

In shallow-water mud, Eastbourne, Sussex (Parker).

Bolivina difformis, Williamson, sp.

Textularia variabilis, var. *difformis*, Williamson, 1858, Rec. For. Gt. Br., p. 77, pl. vi. figs. 166, 167.
" *agglutinans*, var. *difformis*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.
Bolivina pygmæa, Brady, 1884, Challenger Report, p. 421, pl. liii. figs. 5, 6.

This is doubtless, as Messrs. Balkwill and Wright observe, a true *Bolivina;* and if so, the *Bolivina pygmæa* of the 'Challenger' Report may be merged into the same species.

It is a comparatively rare form on the British coast. Williamson gives no localities. It is, however, recorded from Shetland (Brady, Waller); estuary of the Dee (Siddall); Mount's Bay (Millett); Irish Sea (Balkwill and Wright); Galway (Balkwill and Millett); and the south-west of Ireland (Wright).

Bolivina dilatata, Reuss.

Bolivina dilatata, Reuss, 1849, Denkschr. d. k. Ak. Wiss. Wien, vol. i. p. 381, pl. xlviii. fig. 15.
Textularia variabilis, var. *spathulata*, Williamson, 1858, Rec. For. Gt. Br., p. 76, pl. vi. figs. 164, 165.
Bolivina dilatata, Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

Torquay, Shetland (Williamson); Mount's Bay (Millett); Portree Bay, Skye (Robertson); Irish Sea, very rare (Balkwill and Wright); south-west of Ireland, common (Wright).

Bolivina lævigata, Williamson, sp.

Textularia variabilis, var. *lævigata*, Williamson, 1858, Rec. For. Gt. Br., p. 77, pl. vi. fig. 168.
Bolivina textilarioides, Reuss, 1862, Sitzungsb. d. k. Akad. Wiss. Wien, vol. xlvi. p. 81, pl. x. fig. i.
„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 334.

Off Dublin coast, rare (Balkwill and Wright); Mount's Bay (Millett); south-west of Ireland (Wright); shore-sand, Galway (Balkwill and Millett).

Messrs. Balkwill and Millett are probably correct in associating Williamson's *Textularia variabilis*, var. *lævigata* with Reuss's better known species. The change of name, however, entails a certain amount of inconvenience, as the term "*lævigata*" has been recently used by Karrer for a somewhat different modification of the type.

Bolivina ænariensis, Costa, sp.

Brizalina ænariensis, Costa, 1856, Atti dell' Accad. Pont., vol. vii. p. 297, pl. xv. fig. 1.
Bolivina costata, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 55.
„ *ænariensis*, Id., 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 56.

Estuary of the Dee (Siddall).

Sub-family 3. **Cassidulininæ.**

Cassidulina, d'Orbigny.

Cassidulina lævigata, d'Orbigny.

Cassidulina lævigata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 282, No. 1, pl. xv. figs. 4, 5;—Modèle, No. 41.
„ „ Williamson, 1858, Rec. For. Gt. Br., p. 68, pl. vi. figs. 141, 142.

Rare at depths of less than 30 fathoms or thereabouts, but comparatively common in deeper water off Shetland, the west of Scotland, and the west and south of Ireland.

No good purpose is served by attempting to separate *Cassidulina*

pulchella, d'Orbigny, from the typical *C. lævigata;* a few specimens with the sharp peripheral edge becoming slightly carinate are generally met with where the typical form abounds.

Cassidulina crassa, d'Orbigny.

Cassidulina crassa, d'Orbigny, 1839, Foram. Amér. Mérid., p. 56, pl. vii. figs. 18–20.
„ *obtusa*, Williamson, 1858, Rec. For. Gt. Br., p. 69, pl. vi. figs. 143, 144.

Distribution similar to that of *C. lævigata*, but it appears to frequent somewhat shallower water, and is not unfrequently found under such conditions where its congener is absent.

The *Cassidulina oblonga* of Reuss cannot be separated from this species.

Cassidulina bradyi, Norman.

Cassidulina bradyi (Norman MS.), Wright, 1880, Proc. Belfast Nat. Field Club (1879–80) Appendix, p. 152.
„ „ Brady, 1884, Challenger Report, p. 431, pl. liv. figs. 6–10.

South and west of Ireland, 54 to 120 fathoms (Norman, Wright, Brady).

Family VI. CHILOSTOMELLIDÆ.

Chilostomella, Reuss.

Chilostomella ovoidea, Reuss.

Chilostomella ovoidea, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 380, pl. xlviii. fig. 12.
„ „ Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 66, pl. viii. figs. 11, 12.

Off Valentia, 112 fathoms (Norman); south-west of Ireland, 48 to 110 fathoms (Wright).

Family VII. LAGENIDÆ.

Sub-family 1. Lageninæ.

Lagena, Walker and Boys.

Lagena globosa, Montagu, sp.

Vermiculum globosum, Montagu, 1803, Test. Brit., p. 523.
Entosolenia globosa, Williamson, 1858, Rec. For. Gt. Br., p. 8, pl. i. fig. 15, 16.

Common.

Lagena lævis, Montagu, sp.

Vermiculum læve, Montagu, 1803, Test. Brit., p. 524.
Lagena vulgaris, Williamson, 1858, Rec. For. Gt. Br., p. 4, pl. i. figs. 5, 5*a*.

Common.

Lagena clavata, d'Orbigny, sp.

Oolina clavata, d'Orbigny, 1846, For. Foss. Vien., p. 24, pl. i. figs. 2, 3.
Lagena vulgaris, var. *clavata*, Williamson, 1858, Rec. For. Gt. Br., p. 5, pl. i. fig. 6.

The fusiform, pointed variety of *L. lævis*, and probably equally common.

Lagena gracillima, Seguenza, sp.

Amphorina gracillima, Seguenza, 1862, Foram. Monotal. Mess., p. 51, pl. i. fig. 37.
Lagena gracillima, Brady, 1870, Edinburgh Catalogue, p. 4.

Not unfrequent on muddy bottoms.

Lagena aspera, Reuss.

Lagena aspera, Reuss, 1861, Sitzungsb. d. k. Ak. Wiss. Wien, vol. xliv. p. 305, pl. i. fig. 5.
" " Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 48.

Estuary of the Dee (Siddall); Dublin coast and Irish Sea (Balkwill and Wright); Galway (Balkwill and Millett); Killybegs Harbour (Wright).

Lagena hispida, Reuss.

Lagena hispida, Reuss, 1858, Zeitschr. d. deutsch. geol. Gesell., vol. x. p. 434.
" *jeffreysii*, Brady, 1866, Report Brit. Assoc., Nottingham Meeting,—Trans. p. 70.

West of Scotland, and various points on the coast of Ireland, rare; estuary of the Dee, rare.

Lagena jeffreysii appears to have no distinctive characters sufficiently constant to entitle it to separate treatment.

Lagena lineata, Williamson, sp.

Entosolenia globosa, var. *lineata*, Williamson, 1858, Rec. For. Gt. Br., p. 9, pl. i. fig. 17.
Lagena caudata, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 309.

Widely distributed.

Lagena distoma, Parker and Jones.

Lagena distoma, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 467, pl. xlviii. fig. 6.
Lagena sulcata, var. *distoma*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 356, pl. xiii. fig. 20.

Found sparingly all round the coast.

Lagena curvilineata, Balkwill and Wright.

Lagena curvilineata, Balkwill and Wright, 1885, Trans. R. Irish. Acad., vol. xxviii. (Science) p. 338, pl. xiv. figs. 21–24.

Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett); Loch Fyne (Robertson); Mount's Bay (Millett).

Lagena sulcata, Walker and Jacob, sp.

Serpula (*Lagena*) *sulcata*, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 634, pl. xiv. fig. 5.
Lagena vulgaris, var. *perlucida* (pars), Williamson, 1885, Rec. For. Gt. Br., p. 5, pl. i. fig. 8.
" " var. *striata*, Id. Ibid., p. 6. pl. i. fig. 10.
" " var. *interrupta*, Id. Ibid., p. 7, pl. i. fig. 11.
Common.

The apiculate forms of *Lagena sulcata* and *L. costata* constitute the *Amphorina lyellii* and *A. costata* of Seguenza; and it is probable, as suggested by the Rev. Dr. Norman, that portions of *Nodosaria scalaris*, var. *separans* have also been assigned to this group.

Lagena williamsoni, Alcock, sp.

Entosolenia williamsoni, Alcock, 1865, Proc. Lit. and Phil. Soc. Manchester, vol. iv. p. 195.
Lagena williamsoni, Wright, 1877, Proc. Belfast Nat. Field Club, 1876–77, Appendix, p. 104, pl. iv. fig. 14.
Common.

Lagena costata, Williamson, sp.

Entosolenia costata, Williamson, 1858, Rec. For. Gt. Br., p. 9, pl. i. fig. 18.
Lagena costata, Wright, 1877, Proc. Belfast Nat. Field Club, 1876–77, Appendix, p. 103, pl. iv. figs. 11–13.
Not uncommon in dredgings from moderate depths.

Lagena striata, d'Orbigny, sp.

Oolina striata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 21, pl. v. fig. 12.
Lagena vulgaris, var. *substriata*, Williamson, 1858, Rec. For. Gt. Br., p. 7, pl. i. fig. 14.
Common.

Lagena gracilis, Williamson.

Lagena gracilis, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 13, pl. i. fig. 5.
" *vulgaris*, var. *gracilis*, Id. 1858, Rec. For. Gt. Br., p. 7, pl. i. figs. 12, 13.
Generally distributed, though scarcely so common as *L. striata*.

Lagena semistriata, Williamson.

Lagena striata, var. *semistriata*, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 14, pl. i. figs. 9, 10.
" *vulgaris*, var. *semistriata*, Id. 1858, Rec. For. Gt. Br., p. 6, pl. i. fig. 9.
Common.

Lagena striatopunctata, Parker and Jones.

Lagena sulcata, var. *striatopunctata*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 350, pl. xiii. figs. 25–27.
„ *striatopunctata*, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 53.

Estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); Strangford Lough (Wright).

Lagena feildeniana, Brady.

Lagena fieldeniana, Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 434, pl. xx. fig. 4.
„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 339, pl. xiv. fig. 19.

Irish Sea (Balkwill and Wright); estuary of the Dee (Siddall).

Lagena crenata, Parker and Jones.

Lagena crenata, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 420, pl. xviii. fig. 4.
„ „ Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

Dog's Bay, Connemara (Alcock); Hebrides (Brady); Shetland (Waller); Dublin Bay (Balkwill and Wright); south-west of Ireland (Wright).

Lagena squamosa, Montagu, sp.

Vermiculum squamosum, Montagu, 1803, Test. Brit., p. 526, pl. xiv. fig. 2.
Entosolenia squamosa Williamson, 1858, Rec. For. Gt. Br., p. 12, pl. i. fig. 29.

Common.

Lagena hexagona, Williamson, sp.

Entosolenia squamosa, var. *hexagona*, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 20, pl. ii. fig. 23.
„ „ „ Id., 1858, Rec. For. Gt. Br., p. 13, pl. i. fig. 32.
„ „ var. *scalariformis*, Id., Ibid., p. 13, pl. i. fig. 30.

Common.

Lagena melo, d'Orbigny, sp.

Oolina melo, d'Orbigny, 1839, Foram. Amér. Mérid., p. 20, pl. v. fig. 9.
Entosolenia squamosa, var. *catenulata*, Williamson, 1858, Rec. For. Gt. Br., p. 13, pl. i. fig. 31.

Probably widely distributed, but characteristic specimens are certainly less common than the allied reticulate forms.

Lagena lævigata, Reuss, sp.

Fissurina lævigata, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlvi. fig. 1.

Lagena lævigata, Robertson, 1883, Trans. Geol. Soc. Glasgow, vol. vii. p. 24.

Common.

Trifacial specimens of this species have been named by Seguenza *Trigonulina oblonga*, by Siddall *Lagena trigono-oblonga*, and by Balkwill and Millett *Lagena trigono-lævigata*. Such examples are rare, but are occasionally met with when the typical form is plentiful.

Lagena faba, Balkwill and Millett.

Lagena faba, Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol iii. p. 81, pl. ii. fig. 10.

Galway (Balkwill and Millett).

The authors above quoted describe trifacial specimens of the same variety under the name *Lagena trigono-faba*.

A very similar form to the *Fissurina aperta* of Seguenza, the latter being slightly carinate. I greatly doubt the wisdom of attempting to separate such specimens from *Lagena lævigata* and *L. marginata*.

Lagena marginata, Walker and Boys.

Serpula (*Lagena*) *marginata*, Walker and Boys, 1784, Test. Min., p. 2, pl. i. fig. 7.

Entosolenia marginata (pars), Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 17, pl. ii. figs. 15, 16.

" " (pars), Id., 1858, Rec. For. Gt. Br., p. 10, pl. i. fig. 21.

Common.

Trifacial specimens are described under the name *Trigonulina globosa* by Seguenza, and as *Lagena trigono-elliptica* by Balkwill and Millett. The mucronate form is the *Fissurina pedunculata* of Seguenza, and the *Lagena marginata*, var. *pedunculata* of Balkwill and Millett.

Lagena lucida, Williamson, sp.

Entosolenia marginata, var. *lucida*, Williamson, 1858, Rec. For. Gt. Br., p. 10, pl. i. figs. 22, 23.

Not uncommon.

A variety of *L. lævigata*, broadest near the base. Apiculate specimens of the same form constitute the *Fissurina acuta* of Reuss.

Lagena quadrata, Williamson, sp.

Entosolenia marginata, var. *quadrata*, Williamson, 1858, Rec. For. Gt. Br., p. 11, pl. i. figs. 27, 28.

Scarcely separable in point of distribution from the other varieties of *L. marginata*.

Partially carinate specimens are named *Lagena quadrata*, var. *semialata* by Messrs. Balkwill and Millett.

Lagena bicarinata, Terquem, sp.

Fissurina bicarinata, Terquem, 1882, Mém. Soc. géol. France, sér. 3, vol. ii. Mém. III. p. 31, pl. i. fig. 24.

Lagena bicarinata, Balkwill and Millett, 1884, Journ Microsc. and Nat. Sci., vol. iii. p. 82, pl. iii. fig. 9.

Shore-sand, Galway (Balkwill and Millett); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright);—very rare.

Trifacial specimens constitute the *Lagena trigono-bicarinata* of Messrs. Balkwill and Millett's memoir.

Lagena orbignyana, Seguenza, sp.

Fissurina orbignyana, Seguenza, 1862, Foram. Monotal. Mess., p. 66, pl. ii. figs. 25, 26.

Entosolenia marginata (pars), Williamson, 1858, Rec. For. Gt. Br., p. 9, pl. i. figs. 19, 20.

Common.

The trifacial form is named *Lagena trigono-marginata* by Parker and Jones, and *Lagena trigono-orbignyana* by Balkwill and Millett; and quadrifacial specimens *Lagena quadrigono-orbignyana* by the latter authors.

Lagena castrensis, Schwager.

Lagena castrensis, Schwager, 1866, Novara-Exped., geol. Theil, vol. ii. p. 208, pl. v. fig. 22.

" " Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 341, pl. xii. figs. 20, 21.

Off Lambay, 45 to 50 fathoms, very rare (Balkwill and Wright).

Lagena clathrata, Brady.

Lagena clathrata, Brady, 1884, Challenger Report, p. 485, pl. lx. fig. 4.

" " Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. ii. fig. 14.

Shore-sand, Galway (Balkwill and Millett).

The same authors record quadrifacial specimens under the name of *Lagena quadrigono-clathrata*.

Lagena pulchella, Brady.

Lagena pulchella, Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

" " Id., 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 294, pl. 12, fig. 1.

Granton Harbour, Fintry Bay, Cumbrae (Brady); Oban (Robertson); shore-sand, Galway (Balkwill and Millett); Dublin coast (Balkwill and Wright).

Messrs. Balkwill and Millett have also trifacial specimens which they name *Lagena trigono-pulchella*.

Lagena lagenoides, Williamson, sp.

Entosolenia marginata, var. *lagenoides*, Williamson, 1858, Rec. For. Gt. Br., p. 11, pl. i. figs, 25, 26.

Sparsely distributed all round the coast.

Messrs. Balkwill and Wright regard the form which I have named *Lagena trigono-ornata* (Challenger Report, p. 483, pl. lxi. fig. 14), as the trifacial modification of this species. To me the 'Challenger' specimens appear to be in closer relationship with *Lagena ornata*, Will.; it is probable, however, that both varieties (if they are separable) are represented in the trifacial series.

Lagena lagenoides, var. *tenuistriata*, Brady.

Lagena tubulifera, var. *tenuistriata*, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 61.
„ *lagenoides*, var. *tenuistriata*, Id., 1884, Challenger Report, p. 479, pl. lx. figs. 11, 15, 16.
„ „ „ Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. ii. fig. 12.

Shore-sand, Galway (Balkwill and Millett); occasionally met with round the Irish coast (Wright).

From the same locality the last-named authors obtained trifacial specimens which they call *Lagena trigono-tenuistriata.*

Lagena ornata, Williamson, sp.

Entosolenia marginata, var. *ornata*, Williamson, 1858, Rec. For. Gt. Br., p. 11, pl. i. fig. 24.

Whitehaven; Shetland (Williamson). This form has been so much associated with *L. lagenoides*, that it is difficult to lay down the distribution of either as distinct from the other.

Lagena fimbriata, Brady.

Lagena fimbriata, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 61.
„ „ Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. ii. fig. 5.

Shore-sand, Galway (Balkwill and Millett); south-west of Ireland, 40 to 110 fathoms (Wright).

Sub-family 2. **Nodosarinæ.**

Nodosaria, Lamarck.

Nodosaria lævigata, d'Orbigny.

Nodosaria (*Glandulina*) *lævigata*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 252, No. 1, pl. x. figs. 1–3.
Glandulina lævigata, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 468, pl. xlviii. fig. 7.

Shetland (Waller, Brady); Cumbrae (Robertson); south-west of Ireland (Wright).

Nodosaria rotundata, Reuss, sp.

Glandulina rotundata, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlvi. fig. 2.

Nodosaria (Glandulina) rotundata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 612.

South-west of Ireland, 79 to 120 fathoms (Wright).

Nodosaria radicula, Linné, sp.

Nautilus radicula, Linné, 1767, Syst. Nat., 12th ed., p. 1164, 285;—1788, Ibid. 13th (Gmelin's) ed., vol. i. pt. 6, p. 3373, No. 18.

Nodosaria radicula, Brady, 1870, Edinburgh Catalogue, p. 8.

West of Scotland (Brady); estuary of the Dee (Siddall); off the Isle of Man (Balkwill and Wright); south-west of Ireland (Wright); in all localities very rare.

Nodosaria pyrula, d'Orbigny.

Nodosaria pyrula, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 253, No. 13;—Soldani, Testac., vol. ii. p. 35, pl. x. figs. *b*, *c*.

" " Williamson, 1858, Rec. For. Gt. Br., p. 17, pl. ii. fig. 39.

Dentalina guttifera, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 296, pl. xii. fig. 2.

Found sparingly in dredged sands from almost every part of the coast.

Curved specimens of this form have been recorded under the name of *Dentalina guttifera*.

Nodosaria consobrina, d'Orbigny, sp.

Dentalina consobrina, d'Orbigny, 1846, For. Foss. Vien., p. 46, pl. ii. figs. 1–3.

" " Robertson, 1875, Report Brit. Assoc., Bristol Meeting, p. 190.

Durham coast (Robertson); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright).

Nodosaria humilis, Roemer.

Nodosaria humilis, Roemer, 1841, Verstein. Norddeutsch. Kreid., pt. ii. p. 95, pl. xv. fig. 6.

" " Siddall, 1879, Cat. Brit. Rec. For., p. 6.

Shetland (Brady).

Perhaps a needless species, the specimens of which might be assigned either to *N. radicula* or to *N. (Gl.) æqualis*.

Nodosaria communis, d'Orbigny.

Nodosaria (Dentalina) communis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 254, No. 35.

Dentalina subarcuata, Williamson, 1858, Rec. For. Gt. Br., p. 18, pl. ii. figs. 40, 41.

Generally distributed.

Short stout specimens, with few chambers, have sometimes been separately treated under the name *Dentalina brevis*.

Nodosaria pauperata, d'Orbigny, sp.

Dentalina pauperata, d'Orbigny, 1846, For. Foss. Vien., p. 46, pl. i. figs. 57, 58.
„ „ Robertson, 1875, Report Brit. Assoc., Bristol Meeting, p. 190.

Found occasionally with the allied unornamented varieties.

Nodosaria hispida, d'Orbigny.

Nodosaria hispida, d'Orbigny, 1846, For. Foss. Vien., p. 35, pl. i. figs. 24, 25.
„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science), p. 343, pl. xii. fig. 31.

Irish Sea, off the Isle of Man (Elcock, Balkwill and Wright); estuary of the Dee (Siddall).

Nodosaria scalaris, Batsch, sp.

Nautilus (Orthoceras) scalaris, Batsch, 1791, Conchyl. des Seesandes, No. 4, pl. ii. fig. 4.
Nodosaria radicula, Williamson, 1858, Rec. For. Gt. Br., p. 15, pl. ii. figs. 36–38.

Generally distributed. Mr. Wright reports specimens of *N. scalaris*, var. *separans*, from south-west of Ireland, 40 to 200 fathoms.

Nodosaria raphanus, Linné, sp.

Nautilus raphanus, Linné, 1767, Syst. Nat., 12th ed., p. 1164, 283;—1788, Ibid., 13th (Gmelin's) ed., p. 3372, No. 16.
Dentalina subarcuata, var. *jugosa* (pars), Williamson, 1858, Rec. For. Gt. Br., p. 20, pl. ii. fig. 43.

Shetland (Brady); south-west of Ireland, 100 to 200 fathoms (Wright).

Nodosaria raphanistrum, Linné, sp., has been sometimes admitted to the list of British recent species on the evidence of one of the figures in Prof. Williamson's work (Pl. ii. fig. 44). The drawing in question is from a broken specimen, and is associated by the author with two others, which are now regarded as representing *Nodosaria obliqua* and *N. raphanus* respectively. The habitat is not given, and it appears even possible that the specimen, like some other Nodosarinæ on the same plate, may be a derived fossil. Whilst there is this uncertainty it is evident that *N. raphanistrum* is better omitted from our list.

Nodosaria obliqua, Linné, sp.

Nautilus obliquus, Linné, 1767, Syst. Nat., 12th ed., p. 1163, 281;—1788, Ibid., 13th (Gmelin's) ed., p. 3372, No. 14.
Dentalina subarcuata, var. *jugosa* (pars), Williamson, 1858, Rec. For. Gt. Br., p. 20, pl. ii. fig. 42.
„ *obliquestriata*, Robertson, 1875, Report. Brit. Assoc., Bristol Meeting, p. 190.

Widely distributed, but the number of specimens generally small.

Specimens with oblique costæ cannot be separated specifically from the straight-ribbed forms; every shade of variation in this particular is to be met with.

Dentalina obliqua, "d'Orbigny," is noticeable in several British lists, a perpetuation probably of an error of my own, the present form being intended. D'Orbigny's "*obliqua*" is now known under Neugeboren's name *Nodosaria* (*Dentalina*) *mucronata,* and there is no certain evidence of the occurrence of this variety on our shores.

Lingulina, d'Orbigny.

Lingulina carinata, d'Orbigny.

Lingulina carinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 257, No. 1;—Modèle, No. 26.
" " Williamson, 1858, Rec. For. Gt. Br., p. 14, pl. ii. figs. 33–35.

Shetland, Skye, Plymouth Sound (Williamson); Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett); Killybegs Harbour (Wright).

Vaginulina, d'Orbigny.

Vaginulina legumen, Linné, sp.

Nautilus legumen, Linné, 1758, Syst. Nat., 10th ed., p. 711, No. 248;—1767, Ibid., 12th ed., p. 1164, No. 288.
Dentalina legumen, Williamson, 1858, Rec. For. Gt. Br., p. 21, pl. ii. fig. 45.

Widely distributed.

Vaginulina linearis, Montagu, sp.

Nautilus linearis, Montagu, 1808, Test. Brit., Suppl., p. 87, pl. xxx. fig. 9.
Dentalina legumen, var. *linearis,* Williamson, 1858, Rec. For. Gt. Br., p. 23, pl. ii. figs. 46–48.

Widely distributed.

Rhabdogonium, Reuss.

Rhabdogonium tricarinatum, d'Orbigny, sp.

Vaginulina tricarinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 258, No. 4;—Modèle, No. 4.
Rhabdogonium tricarinatum, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 344, pl. xii. figs. 17, 18.

Lambay? (Balkwill and Wright); south-west of Ireland, 100 to 200 fathoms (Wright).

Marginulina, d'Orbigny.

Marginulina glabra, d'Orbigny.

Marginulina glabra, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 259, No. 6;—Modèle, No. 55.

Marginulina glabra, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 296, pl. xii. fig. 3.

Occasional specimens at many points both of the British and Irish coast.

Marginulina costata, Batsch, sp.

Nautilus (*Orthoceras*) *costatus*, Batsch, 1791, Conchyl. des Seesandes, p. 2, pl. 1, fig. 1.

Marginulina raphanus, Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

Hebrides (Brady); estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright); specimens rare and except in the last-named locality usually small.

Cristellaria, Lamarck.

Cristellaria elongata, Williamson.

Cristellaria subarcuatula, var. *elongata*, Williamson, 1858, Rec. For. Gt. Br., p. 30, pl. ii. fig. 62.

Marginulina lituus, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 310.

Killybegs Harbour (Wright). Williamson gives no locality for his specimen.

In so far as the generic distinction is of any value, Williamson's figure is that of a *Cristellaria*, not a *Marginulina*. It differs little, if at all, from the *Cristellaria obtusata* of Reuss.

Cristellaria crepidula, Fichtel and Moll, sp.

Nautilus crepidula, Fichtel and Moll, 1803, Test. Micr., p. 107, pl. xix. figs. *g–i*.

Cristellaria subarcuatula, Williamson, 1858, Rec. For. Gt. Br., p. 29, pl. ii. figs. 56, 57.

Widely distributed.

Cristellaria rotulata, Lamarck, sp.

Lenticulites rotulata, Lamarck, 1804, Ann. du Muséum, vol. v. p. 188, No. 3;—Tableau Encycl. et Méth., pl. ccccl xvi. fig. 5.

Cristellaria calcar (*typica*), Williamson, 1858, Rec. For. Gt. Br., p. 27, pl. ii. figs. 52, 53.

Widely distributed.

Cristellaria cultrata, Montfort, sp.

Robulus cultratus, Montfort, 1808, Conchyl. Systém., vol. i. p. 214, 54^{e} genre.

Cristellaria cultrata, Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

Carinate *Cristellariæ* are rare in the British seas. Occasional specimens are found associated with *C. rotulata*, but they are invariably small and the peripheral keel only slightly developed.

Cristellaria vortex, Fichtel and Moll, sp.

Nautilus vortex, Fichtel and Moll, 1803, Test. Micr., p. 33, pl. ii. figs. *d–i*.
Cristellaria vortex, Brady, 1870, Edinburgh Catalogue, p. 8.

Small starved specimens, doubtfully referrible to this species, from the west coast of Scotland.

Cristellaria variabilis, Reuss.

Cristellaria variabilis, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 369, pl. xlvi. figs. 15, 16.
„ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 612.

South-west of Ireland, 100 to 200 fathoms, rare (Wright).

Cristellaria italica, Defrance, sp.

Saracenaria italica, Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177;—vol. xlvii. p. 344;—Atlas Conch., pl. xiii. fig. 6.
Cristellaria subarcuatula, var. *scapha*, Williamson, 1858, Rec. For. Gt. Br., p. 30, pl. ii. figs. 60, 61.

Estuary of the Dee, rare (Siddall). Williamson gives no locality for the broken specimen figured in his work.

Amphicoryne, Schlumberger.

Amphicoryne falx, Jones and Parker, sp.

Marginulina falx, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 302, No. 28.

South-west of Ireland, 79 to 400 fathoms, rare (Wright).

Sub-family 3. **Polymorphininæ.**

Polymorphina, d'Orbigny.

Polymorphina lactea, Walker and Jacob, sp.

Serpula lactea, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 634, pl. xiv. fig. 4.
Polymorphina lactea (*typica*), pars, Williamson, 1858, Rec. For. Gt. Br., p. 70, pl. vi. fig. 147.
„ „ var. *communis*, Id., Ibid., p. 72, pl. vi. figs. 153–155.

Generally distributed.

Polymorphina gibba, d'Orbigny.

Polymorphina (*Globulina*) *gibba*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, No. 20;—Modèle, No. 63.
„ *gibba*, Brady, 1870, Edinburgh Catalogue, p. 5.

Scarcely separable either in characters or distribution from the foregoing species. Futile attempts have been made (by myself amongst others) to distinguish the more or less compressed specimens both of

P. lactea and *P. gibba* by varietal names—*P. lactea*, var. *amygdaloides*, Reuss, and *P. gibba*, var. *æqualis*, d'Orbigny—respectively; but the distinction has not been found to possess the least zoological value.

Polymorphina problema, d'Orbigny.

Polymorphina (*Guttulina*) *problema*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, No. 14;—Modèle, No. 61.
„ „ *communis*, Id., Ibid., p. 266, No. 15, pl. xii. figs. 1–4;—Modèle, No. 62.
„ *communis*, Brady, 1870, Edinburgh Catalogue, p. 5.

Widely distributed.

It is quite impossible to separate *Polymorphina communis* from *P. problema*, and as d'Orbigny's model of the latter form presents the best developed characters, I have followed Reuss in accepting it as the type.

Polymorphina lactea, var. *oblonga*, Williamson.

Polymorphina lactea, var. *oblonga*, Williamson, 1858, Rec. For. Gt. Br., p. 71, pl. vi. figs. 149, 149*a*.

Widely distributed.

I have for the moment retained the trivial name "*oblonga*" just as given by Williamson, that is to say varietally. The same term had been used twice previously in connection with the genus, namely by Roemer (Neues Jahrb. für Min., &c., 1838, p. 386, pl. iii. fig. 34) and by d'Orbigny (For. Foss. Vien., p. 232, pl. xii. figs. 29–31). Roemer's specimens, so far as can be judged from his figure, may be disposed of by referring them to *P. communis* or *P. problema;* and those from the Vienna Basin might be fitly assigned to the earlier d'Orbignyan species *P. soldanii* (Ann. Sci. Nat., vol. vii. p. 265, No. 12). If this course be adopted Williamson's form, which has tolerably distinctive characters, will stand as *Polymorphina oblonga.*

Polymorphina thouini, d'Orbigny.

Polymorphina thouini, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 265, No. 8;—Modèle, No. 23.
„ „ Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 48.

Estuary of the Dee, very rare (Siddall).

Polymorphina lanceolata, Reuss.

Polymorphina lanceolata, Reuss, 1851, Zeitschr. d. deutsch. geol. Gesell., vol. iii. p. 83, pl. vi. fig. 50.
„ *fusiformis*, pars, Brady, Parker and Jones, 1870, Trans. Linn. Soc. Lond., vol. xxvii. p. 219, pl. xxxix. fig. 5, *b*, *c*.
„ *lanceolata*, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Robin Hood's Bay, Yorkshire; Loch Fyne (Robertson); estuary of the Dee (Siddall); Dublin coast (Balkwill and Wright); south-west of Ireland (Wright). Probably this list is far from complete.

Polymorphina cylindroides, Roemer.

Polymorphina cylindroides, Roemer, 1838, Neues Jahrb. für Min., &c., p. 385, pl. iii. fig. 26.
,, *lactea*, var. *acuminata*, Williamson, 1858, Rec. For. Gt. Br., p. 71, pl. vi. fig. 148.

Skye (Williamson); Shetland (Waller).

Polymorphina compressa, d'Orbigny.

Polymorphina compressa, d'Orbigny, 1846, For. Foss. Vien., p. 233, pl. xii. figs. 32–34.
,, *lactea* (*typica*), pars, Williamson, 1858, Rec. For. Gt. Br., p. 70, pl. vi. figs. 145, 146.

Generally distributed.

Polymorphina complanata, d'Orbigny.

Polymorphina complanata, d'Orbigny, 1846, For. Fos. Vien., p. 234, pl. xiii. figs. 25–30.
,, ,, Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 84, pl. iv. fig. 9.

Shore-sand, Galway (Balkwill and Millett).

Polymorphina sororia, Reuss.

Polymorphina (*Guttulina*) *sororia*, Reuss, 1862, Bull. Acad. Roy. Belg., sér. 2, vol. xv. p. 151, pl. ii. figs. 25–29.
,, *sororia*, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

The cuspidate variety of this form has been dredged by Mr. Robertson in Loch Fyne, and by Mr. Wright off the south-west of Ireland.

Polymorphina rotundata, Bornemann, sp.

Guttulina rotundata, Bornemann, 1855, Zeitschr. d. deutsch. geol. Gesell., vol. vii. p. 346, pl. xviii. fig. 3.
Polymorphina rotundata, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Oban and Loch Fyne (Robertson); north of Ireland (Wright); Dublin coast (Balkwill and Wright).

Polymorphina concava, Williamson.

Polymorphina lactea, var. *concava*, Williamson, 1858, Rec. For. Gt. Br., p. 72, pl. vi. figs. 151, 152.

Brixham (Williamson); estuary of the Dee (Siddall); South Donegal (Wright); south-west of Ireland, 110 fathoms (Wright); Mount's Bay (Millett); Dublin coast (Balkwill and Wright).

Polymorphina myristiformis, Williamson.

Polymorphina myristiformis, Williamson, 1858, Rec. For. Gt. Br., p. 73, pl. vi. figs. 156, 157.

Widely distributed, and in certain localities very common.

Polymorphina spinosa, d'Orbigny, sp.

Globulina spinosa, d'Orbigny, 1846, For. Foss. Vien., p. 230, pl. xiii. figs. 23, 24.
Polymorphina spinosa, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 48.

Estuary of the Dee, very rare (Siddall); Dublin coast, very rare (Balkwill and Wright).

UVIGERINA, d'Orbigny.

Uvigerina pygmæa, d'Orbigny.

Uvigerina pygmæa, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 2, pl. xii. figs. 8, 9;—Modèle, No. 67.
„ „ Williamson, 1858, Rec. For. Gt. Br., p. 66, pl. v. figs. 138, 139.

Not uncommon at depths of 30 fathoms and more; rarely met with in shallower water.

Uvigerina angulosa, Williamson.

Uvigerina angulosa, Williamson, 1858, Rec. For. Gt. Br., p. 67, pl. v. fig. 140.

Much more frequent in our seas than the typical form *U. pygmæa*, and occurring in shallower water.

Uvigerina canariensis, d'Orbigny.

Uvigerina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 138, pl. i. figs. 25–27.
„ *irregularis*, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 100, pl. xii. fig. 5.

Off Holy Island (Brady); estuary of the Dee (Siddall); south-west of Ireland (Wright); in all of these localities very rare.

SAGRINA, Parker and Jones.

Sagrina dimorpha, Parker and Jones.

Uvigerina (Sagrina) dimorpha, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 420, pl. xviii. fig. 18.

Mr. Robertson has tolerably well-marked specimens of this form from low-water, Howport, Girvan.

Sub-family 4. **Ramulininæ.**

RAMULINA, Rupert Jones.

(?) *Ramulina globulifera*, Brady.

Ramulina globulifera, Brady, 1869, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 58, pl. viii. figs. 32, 33.
„ sp. Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 83, pl. iv. fig. 7.

Shore-sand, Galway (Balkwill and Millett).

I have placed the broken specimen, figured by the authors above named, provisionally under this species, but it is impossible to speak with much confidence on so slender a groundwork.

Family VIII. GLOBIGERINIDÆ.

Globigerina, d'Orbigny.

Globigerina bulloides, d'Orbigny.

Globigerina bulloides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 277, No. 1;—Modèles, No. 17 (young) and No. 76.
" " Williamson, 1858, Rec. For. Gt. Br., p. 56, pl. v. figs. 116–118.

Comparatively rare on the east coast; common at some distance from land on the Atlantic shores.

Globigerina inflata, d'Orbigny.

Globigerina inflata, d'Orbigny, 1839, Foram. Canaries, p. 134, pl. ii. figs. 7–9.
" " Wright, 1881, Proc. Belfast Nat. Field Club, 1880–81, Appendix, p. 186.

South Donegal (Wright); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright); shore-sand, Galway (Balkwill and Millett); Mount's Bay, Cornwall (Millett); Shetland (Brady).

Globigerina rubra, d'Orbigny.

Globigerina rubra, d'Orbigny, 1839, Foram. Cuba, p. 94, pl. iv. figs. 12–14.
" " Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 613.

South-west of Ireland, 100 to 200 fathoms, rare (Wright).

Globigerina æquilateralis, Brady.

Globigerina æquilateralis, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 285.
" " Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 613.

South-west of Ireland, 48–120 fathoms, rare (Wright); Shetland (Brady).

Orbulina, d'Orbigny.

Orbulina universa, d'Orbigny.

Orbulina universa, d'Orbigny, 1839, Foram. Cuba, p. 3, pl. i. fig. 1.
" " Williamson, 1858, Rec. For. Gt. Br., p. 2, pl. i. fig. 4.

Rare near land, but in deeper water not uncommon, especially on the south and west coasts. Shallow-water specimens often of brown colour. Double specimens, the *Globigerina bilobata* of d'Orbigny, occasionally met with where the species is plentiful.

PULLENIA, Parker and Jones.

Pullenia sphæroides, d'Orbigny, sp.

Nonionina sphæroides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 293, No. 1;—Modèle, No. 43.

Pullenia sphæroides, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 49.

Estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright).

Pullenia quinqueloba, Reuss.

Nonionina quinqueloba, Reuss, 1851, Zeitschr. d. deutsch. geol. Gesell., vol. iii. p. 71, pl. v. fig. 31.

Pullenia quinqueloba, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 348, pl. 12, figs. 29 *a*, *b*.

Lambay Deep, 45 fathoms (Balkwill and Wright); south-west of Ireland (Wright); Shetland (Brady).

SPHÆROIDINA, d'Orbigny.

Sphæroidina bulloides, d'Orbigny.

Sphæroidina bulloides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 267, No. 1;—Modèle, No. 65.

" " Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 613.

South-west of Ireland, 54 to 120 fathoms (Wright).

Mr. Siddall informs me that the specimen assigned to this species in the Dee Catalogue of 1878 appears to be a starved example of *Sph. dehiscens*, under which it is now placed.

Sphæroidina dehiscens, Parker and Jones.

Sphæroidina dehiscens, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 369, pl. xix. fig. 5.

" " Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 58.

One example from the Dee estuary (Siddall).

Family IX. **ROTALIDÆ.**

Sub-family 1. **Spirillininæ.**

SPIRILLINA, Ehrenberg.

Spirillina vivipara, Ehrenberg.

Spirillina vivipara, Ehrenberg, 1841, Abhandl. k. Akad. Wiss. Berlin, p. 442, pl. iii. fig. 41.

" *perforata*, Williamson, 1858, Rec. For. Gt. Br., p. 92, pl. vii. fig. 202.

Generally distributed; specimens, however, not very common.

Spirillina limbata, Brady.

Spirillina limbata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 278, pl. viii. fig. 26.

Spirillina limbata, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 59.

Estuary of the Dee, very rare (Siddall).

Spirillina margaritifera, Williamson.

Spirillina margaritifera, Williamson, 1858, Rec. For. Gt. Br., p. 93, pl. vii. fig. 204.

Estuary of the Dee (Siddall); Mounts Bay, Cornwall (Millett; Williamson gives no locality.

Spirillina tuberculata, Brady.

Spirillina tuberculata, Brady, 1878 (in Siddall's 'Foraminifera of the Dee'), Proc. Chester Soc. Nat. Sci., pt. ii. p. 49;—1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 279, pl. viii. fig. 28.

Off Eddystone (Robertson); estuary of the Dee (Siddall); at several points off the coast of Dublin, and in the Irish Sea (Balkwill and Wright).

I am not by any means confident that this form, or at any rate the British specimens that have been assigned to it, can be separated from *Sp. margaritifera.* Some of the Challenger specimens, notably those from Kerguelen, differ strikingly from Williamson's figure; but then Williamson had only a single specimen, and it may be questioned how far it was typical.

Sub-family 2. **Rotalinæ.**

Patellina, Williamson.

Patellina corrugata, Williamson.

Patellina corrugata, Williamson, 1858, Rec. For. Gt. Br., p. 46, pl. iii. figs. 86–89.

Occurs at intervals all round the coast, usually on muddy bottoms.

Discorbina, Parker and Jones.

Discorbina globularis, d'Orbigny, sp.

Rosalina globularis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 271, No. 1, pl. xiii. figs. 1–4;—Modèle, No. 69.

Rotalina concamerata (young), Williamson, 1858, Rec. For. Gt. Br., p. 53, pl. iv. figs. 104, 105.

Common everywhere.

Discorbina rosacea, d'Orbigny, sp.

Rotalia rosacea, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 273, No. 15;—Modèle, No. 39.

Rotalina mamilla, Williamson, 1858, Rec. For. Gt. Br., p. 54, pl. iv. figs. 109–111.

Widely distributed.

Discorbina orbicularis, Terquem, sp.

Rosalina orbicularis, Terquem, 1876, Anim. sur la Plage de Dunkerque, fasc. ii. p. 75, pl. ix. fig. 4.

Discorbina orbicularis, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 349, pl. xiii. figs. 31–33.

At several points off the Dublin coast, and in the Irish Sea (Balkwill and Wright); Mount's Bay, Cornwall (Millett); shore-sand, Galway (Balkwill and Millett).

Discorbina parisiensis, d'Orbigny, sp.

Rosalina parisiensis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 271, No. 1;—Modèle, No. 38.

Discorbina parisiensis (pars), Wright, 1877, Proc. Belfast Nat. Field Club, 1876–7, Appendix, p. 105, pl. iv. fig. 1.

South Donegal; Down and Antrim (Wright); Dublin coast and Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett); Mount's Bay (Millett).

Discorbina wrightii, Brady.

Discorbina wrightii, Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 104, pl. ii. fig. 6;—Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 413, pl. xxi. fig. 6.

„ *parisiensis* (pars), Wright, 1877, Proc. Belfast Nat. Field Club, 1876–7, Appendix, p. 105, pl. iv. fig. 2.

Coasts of Down and Antrim, and of South Donegal (Wright); various points in the Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett).

In Mr. Siddall's Catalogue of British Recent Foraminifera (1879), *Discorbina obtusa*, d'Orbigny, sp., was included, on the evidence of one or two small specimens, found by myself many years ago in sands dredged amongst the Hebrides; I am now inclined to think, however, that these are better referred to the present closely allied species.

Discorbina tuberculata, Balkwill and Wright.

Discorbina tuberculata, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 350, pl. xiii. figs. 28–30.

Off Dublin coast, and in the Irish Sea (Balkwill and Wright); estuary of the Dee (Siddall).

Discorbina bertheloti, d'Orbigny, sp.

Rosalina bertheloti, d'Orbigny, 1839, Foram. Canaries, p. 135, pl. i. figs. 28–30.

Discorbina bertheloti, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 10.

Shetland (Brady, Waller); various points on the coast of Ireland and in the Irish Sea (Wright, Balkwill and Wright, Balkwill and Millett).

Discorbina biconcava, Parker and Jones.

Discorbina biconcava, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 422, pl. xix. fig. 10.

Discorbina biconcava, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 50.

Estuary of the Dee (Siddall).

PLANORBULINA, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 280, No. 2, pl. xiv. figs. 4–6;—Modèle, No. 79.

„ *vulgaris*, Williamson, 1858, Rec. For. Gt. Br., p. 57, pl. v. figs. 119, 120.

Generally distributed.

TRUNCATULINA, d'Orbigny.

Truncatulina refulgens, Montfort, sp.

Cibicides refulgens, Montfort, 1808, Conchyl. Systém., vol. i. p. 122, 31e Genre.

Truncatulina refulgens, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 105, pl. xii. fig. 9.

Not uncommon in coarse rough sands, from 20 fathoms downwards, on the Atlantic coasts of Scotland and Ireland; rare on the east coast.

Truncatulina lobatula, Walker and Jacob, sp.

Nautilus lobatulus, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 642, pl. xiv. fig. 36.

Truncatulina lobatula, Williamson, 1858, Rec. For. Gt. Br., p. 59, pl. v. figs. 121–123.

One of the commonest British species.

Specimens closely resembling a compact many-chambered variety of *Truncatulina*, recently described by Messrs. Parker and Jones and myself in a paper on some Foraminifera from the Abrohlos Bank (Trans. Zool. Soc. Lond., vol. xii., in the press), are common in Mr. Wright's material from south-east of Ireland. This has been named *Truncatulina mundula*, and the following characters are given for its identification, *loc. cit.* Morphologically its place is near *Tr. haidingerii*, or between that species and *Tr. ungeriana*, its nearest isomorph being *Pulvinulina karsteni.*

"*Truncatulina mundula*, B. P. and J.—Test free, rotaliform; composed of about three convolutions, which are evolute on the superior and completely involute on the inferior side; the outermost whorl of the adult shell consisting of from ten to twelve segments. Superior face slightly convex or subconical, generally coarsely perforate, the sutures and periphery marked by thickening of the chamber-walls; inferior face convex, sometimes a little depressed at the umbilicus, perforations inconspicuous, sutures slightly excavated or marked by fine lines only. Diameter $\frac{1}{60}$th in. (0·42 mm.)." The Irish specimens have rather fewer chambers than above indicated, but otherwise present very similar characters.

Truncatulina haidingerii, d'Orbigny, sp.

Rotalina haidingerii, d'Orbigny, 1846, For. Foss. Vien., p. 154, pl. viii. figs. 7–9.
Planorbulina haidingerii, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 11.

Shetland, 79 to 90 fathoms (Brady, Waller); estuary of the Dee (Siddall);—the examples, so far as they have come under my notice, not very typical.

Truncatulina ungeriana, d'Orbigny, sp.

Rotalina ungeriana, d'Orbigny, 1846, For. Foss. Vien., p. 157, pl. viii. figs. 16–18.
Planorbulina ungeriana, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 12.

Shetland, 75 to 90 fathoms (Brady, Waller); estuary of the Dee (Siddall); south-west of Ireland (Wright).

Anomalina, d'Orbigny.

Anomalina coronata, Parker and Jones.

Anomalina coronata, Parker and Jones, 1857, Ann. and Mag. Nat. Hist., ser. 2, vol. xix. p. 294, pl. x. figs. 15, 16.
„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 13.

Shetland, 75 to 90 fathoms (Brady, Waller).

Pulvinulina, Parker and Jones.

Pulvinulina repanda, Fichtel and Moll, sp.

Nautilus repandus, Fichtel and Moll, 1803, Test. Micr., p. 35, pl. iii. figs. *a–d*.
Rotalina concamerata (mature), Williamson, 1858, Rec. For. Gt. Br., p. 52, pl. iv. figs. 101–103.

The typical *Pulvinulina repanda* is represented by Fichtel and Moll as a Rotaline shell with its two faces nearly equally convex. The form figured by Williamson, and generally met with on our shores, is much more convex on the superior side than on the inferior, and the sutures of the superior aspect are marked by a certain amonnt of external thickening or limbation. The latter form may be distinguished as var. *concamerata*, Montagu, but it is impossible to separate the two by any very constant characters.

I find no record of the occurrence of *Pulvinulina repanda* on the east coast of England or Scotland, nor in the Irish Sea. It is not uncommon in coarse sands dredged on the north and west coasts of Scotland and Ireland, and in the English Channel.

Pulvinulina concentrica, Parker and Jones.

Pulvinulina concentrica, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 393.

Pulvinulina concentrica Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 14.

Shetland, 75 to 90 fathoms (Brady, Waller).

Pulvinulina auricula, Fichtel and Moll, sp.

Nautilus auricula, var. *a*, Fichtel and Moll, 1803, Test. Micr., p. 108, pl. xx. figs. *a, b, c*.

" " var. *β*, Id., Ibid., figs. *d, e, f*.

Rotalina oblonga, Williamson, 1858, Rec. For. Gt. Br., p. 51, pl. iv. figs. 98–100.

Widely distributed.

Pulvinulina menardii, d'Orbigny, sp.

Rotalia menardii, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 273, No. 26;—Modèle, No. 10.

Pulvinulina menardii, Brady, 1863, Report Brit. Assoc., Newcastle-upon-Tyne Meeting, Trans. p. 101.

Off Laxey, Isle of Man, 15 fathoms (Brady); Irish Sea and coast of Dublin (Balkwill and Wright).

Pulvinulina canariensis, d'Orbigny, sp.

Rotalina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 130, pl. i. figs. 34–36.

Pulvinulina canariensis, Brady, 1870, Edinburgh Catalogue, p. 8.

Hebrides (Brady); estuary of the Dee (Siddall); shore-sand, Galway (Balkwill and Millett); south-west of Ireland (Wright).

Pulvinulina patagonica, d'Orbigny, sp.

Rotalina patagonica, d'Orbigny, 1839, Foram. Amér. Mérid., p. 36, pl. ii. figs. 6–8.

Pulvinulina scitula, Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 85, pl. iv. fig. 12.

Shore-sand, Galway, a single specimen (Balkwill and Millett); south-west of Ireland, 54 to 120 fathoms, rare; off Belfast Lough, 30 to 60 fathoms, very rare (Wright).

Pulvinulina micheliniana, d'Orbigny, sp.

Rotalina micheliniana, d'Orbigny, 1840, Mém. Soc. géol. France, vol. iv. p. 31, pl. iii. figs. 1–3.

Pulvinulina micheliniana, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 614.

Various points to the south-west of Ireland, 48 to 120 fathoms (Wright).

Pulvinulina crassa is inserted in the 'Edinburgh Catalogue' (p. 8), on the ground of one or two specimens believed to be referrible to that species obtained from Mr. Jeffreys' Hebrides dredgings. The mounting has unfortunately been mislaid, but it appears to me not improbable that the shells in question may have belonged to the present closely allied form; at any rate, without more evidence than at present exists, the retention of the name in the British list is scarcely warranted.

Pulvinulina karsteni, Reuss, sp.

Rotalia karsteni, Reuss, 1855, Zeitschr. d. deutsch. geol. Gesell., vol. vii. p. 273, pl. ix. fig. 6.
Pulvinulina karsteni, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 15.

Shetland, 75 to 90 fathoms (Brady, Waller); South Donegal (Wright); Irish Sea and Dublin coast (Balkwill and Wright); south-west of Ireland, 79 to 120 fathoms (Wright).

Pulvinulina elegans, d'Orbigny, sp.

Rotalia (*Turbinulina*) *elegans*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 276, No. 54;—Soldani, Saggio Oritt., p. 99, pl. ii. fig. 13.
Rotalina partschiana, d'Orbigny, 1846, For. Foss. Vien., p. 153, pl. vii. figs. 28–30; pl. viii. figs. 1–3.
Pulvinulina elegans, Brady, 1870, Edinburgh Catalogue, p. 7.

Off Laxey, Isle of Man, 15 fathoms; Guernsey, dredged (Brady); south-west of Ireland, 48 to 120 fathoms (Wright).

Rotalia, Lamarck.

Rotalia beccarii, Linné, sp.

Nautilus beccarii, Linné, 1767, Syst. Nat., 12th ed., p. 1162;—1788, Ibid., 13th (Gmelin's) ed., p. 3370, No. 4.
Rotalina beccarii, Williamson, 1858, Rec. For. Gt. Br., p. 48, pl. iv. figs. 90–92.

Generally distributed.

Rotalia orbicularis, d'Orbigny.

Rotalia (*Gyroidina*) *orbicularis*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 278, No. 1;—Modèle, No. 13.
„ *orbicularis*, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 16.

Irish Sea; Shetland (Brady); south-west of Ireland, 100 to 200 fathoms (Wright).

Rotalia nitida, Williamson.

Rotalina nitida, Williamson, 1858, Rec. For. Gt. Br., p. 54, pl. iv. figs. 106–8.

Found at intervals all round the coast.

Sub-family 3. **Tinoporinæ.**

Gypsina, Carter.

Gypsina vesicularis, Parker and Jones, sp.

Orbitolina vesicularis, Parker and Jones, 1860, Ann. and Mag. Nat. Hist., ser. 3, vol. vi. p. 31, No. 5.
Tinoporus lævis, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 17.

Not uncommon on the Atlantic sea-board and in the Irish Sea; not recorded from the east coast of England or Scotland.

Gypsina globulus, Reuss, sp.

Ceriopora globulus, Reuss, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 33, pl. v. fig. 7.
Gypsina globulus, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 614.

A single large specimen reported by Wright from 110 fathoms, south-west of Ireland.

Gypsina inhærens, Schultze, sp.

Acervulina inhærens, Schultze, 1854, Organ. der Polythal., p. 68, pl. vi. fig. 12.
Tinoporus lucidus, Brady, 1870, Edinburgh Catalogue, p. 8.

Generally distributed.

Family X. **NUMMULINIDÆ.**

Sub-family 1. **Fusulininæ.**

Sub-family 2. **Polystomellinæ.**

NONIONINA, d'Orbigny.

Nonionina asterizans, Fichtel and Moll.

Nautilus asterizans, Fichtel and Moll, 1803, Test. Micr., p. 37, pl. iii. figs. *e–h*.
Nonionina asterizans, Brady, 1870, Edinburgh Catalogue, p. 8.

Since becoming better acquainted with the typical *Nonionina asterizans*, through the 'Challenger' collections, I have had considerable doubt whether the species has any claim to a place in the British list. The British specimens which have come under my notice have all been minute, and their characters ambiguous; and I am inclined to think they might generally be referred either to *N. depressula* on the one hand, or *N. stelligera* on the other. Of the distribution of *N. asterizans* as distinct from these two forms there is no satisfactory information.

Nonionina depressula, Walker and Jacob, sp.

Nautilus depressulus, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 641, pl. xiv. fig. 33.
Nonionina umbilicatula, Williamson, 1858, Rec. For. Gt. Br., p. 97, pl. iii. figs. 70, 71.
" *crassula*, Id., Ibid., p. 33.

Generally distributed; one of the commonest Microzoa of shallow pools and estuaries, and of brackish water.

Nonionina umbilicatula, Montagu, sp.

Nautilus umbilicatulus, Montagu, 1803, Test. Brit., p. 191;—Suppl., p. 78, pl. xviii. fig. 1.
Nonionina barleeana, Williamson, 1858, Rec. For. Gt. Br., p. 32, pl. iii. figs. 68, 69.

Widely distributed; affecting much deeper water than the last-named species.

Nonionina orbicularis, Brady.

Nonionina orbicularis, Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 105, pl. ii. fig. 5;—Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 415, pl. xxi. fig. 5.

„ „ Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 274.

Loch Fyne, 25 fathoms (Robertson); off Valentia, 112 fathoms (Norman); south-west of Ireland, 79 to 120 fathoms (Wright).

Nonionina boueana, d'Orbigny.

Nonionina boueana, d'Orbigny, 1846, For. Foss. Vien., p. 108, pl. v. figs. 11, 12.

„ „ Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 85.

Shore-sand Galway? (Balkwill and Millett).

This is not a very satisfactory "species" at best. The shell figured by Messrs. Balkwill and Wright (Trans. R. Irish Acad., vol. xxviii. (Science) pl. xiii. fig. 27) shows the double rows of sutural orifices characteristic of *Polystomella arctica*, and I learn that the authors are now disposed to transfer it to that species. The right of *Nonionina boueana* therefore to a place in the present list depends upon Messrs. Balkwill and Millett's doubtful specimens.

Nonionina pauperata, Balkwill and Wright.

Nonionina pauperata, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 353, p. xiii. figs. 25, 26.

Dublin coast, and various points in the Irish Sea, rather frequent (Balkwill and Wright); south-west of Ireland, 26 fathoms (Wright).

Possibly only the starved condition of *Nonionina scapha*.

Nonionina turgida, Williamson, sp.

Rotalina turgida, Williamson, 1858, Rec. For. Gt. Br., p. 50, pl. iv. figs. 95–97.

Tolerably frequent all round the coast.

Nonionina scapha, Fichtel and Moll, sp.

Nautilus scapha, Fichtel and Moll, 1803, Test. Micr., p. 105, pl. xix. figs. *d–f*.

Nonionina scapha, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 106, pl. xii. fig. 10.

Durham coast (Brady); west of Scotland (Robertson); estuary of the Dee (Siddall); shore-sand, Galway? (Balkwill and Millett); coast of Down and Antrim; south-west of Ireland, 40 to 120 fathoms (Wright).

Nonionina stelligera, d'Orbigny.

Nonionina stelligera, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. iii. figs. 1, 2.

Nonionina stelligera, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 471, pl. xlviii. fig. 19.

Shetland, 80 fathoms (Brady, Waller); estuary of the Dee (Siddall); Mount's Bay (Millett); shore-sand, Galway (Balkwill and Millett); Dublin Bay and Irish Sea (Balkwill and Wright); south-west of Ireland (Wright).

POLYSTOMELLA, Lamarck.

Polystomella crispa, Linné, sp.

Nautilus crispus, Linné, 1767, Syst. Nat., 12th ed., p. 1162, 275;—1788, Ibid., 13th (Gmelin's) ed., p. 3370, No. 3.

Polystomella crispa, Williamson, 1858, Rec. For. Gt. Br., p. 40, pl. iii. figs. 78–80.

Common at all parts of the coast.

Polystomella subnodosa, Münster, sp.

Robulina subnodosa, Münster, 1838 (*fide* Roemer), Neues Jahrb. für Min. &c., p. 391, pl. iii. fig. 61.

Polystomella subnodosa, Wright, 1886, Proc. R. Irish Acad., ser. 2 vol. iv. (Science) p. 614.

South-west of Ireland, 100 to 120 fathoms, frequent (Wright).

Polystomella striatopunctata, Fichtel and Moll, sp.

Nautilus striatopunctatus, Fichtel and Moll, 1803, Test. Micr., p. 61, pl. ix. fig. *a–c*.

Polystomella umbilicatula, Williamson, 1858, Rec. For. Gt. Br., p. 42, pl. iii. figs. 81, 82.

" " var. *incerta*, Id., Ibid., p. 44, pl. iii. fig. 82 *a*.

Generally distributed.

Polystomella arctica, Parker and Jones.

Polystomella crispa, var. *arctica*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 401, pl. xiv. figs. 25–30.

" *arctica*, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 471, pl. xlviii. fig. 18.

Shetland, 75 to 90 fathoms (Brady, Waller); between Portincross and Ardrossan, 30 fathoms (Robertson); Kish Bank, 24 fathoms, very rare (Balkwill and Wright—described and figured as *Nonionina boueana* in their memoir).

Sub-family 3. **Nummulitinæ.**

OPERCULINA, d'Orbigny.

Operculina ammonoides, Gronovius, sp.

Nautilus ammonoides, Gronovius, 1781, Zooph. Gron., p. 282, No. 1220; and p. v.

Nonionina elegans, Williamson, 1858, Rec. For. Gt. Br., p. 35, pl. iii. figs. 74, 75.

Shetland, Hebrides (Williamson, Brady, Waller); Scarborough (Williamson); south-west of Ireland (Wright).

Postscript.—Since the foregoing Synopsis has been in type I have received from my friend M. Schlumberger a copy of a valuable communication, recently made by him to the Zoological Society of France, on the genus *Planispirina* (Bull. Soc. Zool. France, vol. xii. pp. 105–118, pl. vii.), containing a further instalment of his interesting researches on the construction of the test in the various types of *Miliolidæ*. M. Schlumberger's examination of the forms referred to the genus *Planispirina* in the 'Challenger Report' has led him to the conclusion that they exemplify two diverse types of structure sufficiently distinct for generic separation,—one group, for which the term *Planispirina* is retained, embracing *Pl.* (*Biloculina*) *contraria*, d'Orb., *Pl. communis*, Seg., and *Pl. carinata*, Seg. (and, I suppose, *Pl. exigua*, Brady); the other, for which the generic name *Sigmoïlina* is proposed, including *Planispirina sigmoidea*, Brady, *Pl.* (*Spiroloculina*) *celata*, Costa, and a new species *Sigmoïlina edwardsi*, Schlumberger, together with *Quinqueloculina secans*, d'Orb., and *Quinqueloculina tenuis*, Czjzek.

It is not needful here to discuss the relative value of the characters upon which this arrangement is founded. The construction of the test in the species concerned has been worked out with the author's accustomed skill and accuracy, and so far as can be judged the results bear out the conclusions at which he has arrived. That the difficulties referred to on a previous page, as to the position of apparently intermediate forms, like *Quinqueloculina tenuis* and *Q. secans*, are thereby disposed of, is an additional argument in favour of the suggested relationship.

The acceptance of this view would only affect the nomenclature of the present paper in connection with three species, namely,—*Planispirina celata*, *Miliolina secans*, and *Miliolina tenuis*, which would stand respectively as *Sigmoïlina celata*, Costa, sp., *Sigmoïlina secans*, d'Orb., sp., and *Sigmoïlina tenuis*, Czjzek, sp.

XV.—*A New Eye-piece.*

By E. M. Nelson.

(*Read 9th November*, 1887.)

Until quite lately, there have been among Microscopists only two kinds of eye-pieces in general use, viz. the Huyghenian and the Kellner. Recently, however, Prof. Abbe's compensating eye-pieces have been introduced with beneficial results. Of these three forms the Kellner may be dismissed by saying that although one of its lenses is achromatized, its defining power is undoubtedly considered bad by general consent.

The compensating eye-pieces, while being absolutely necessary to some of the apochromatic series of objectives and beneficial to others, improve the definition of ordinary objectives also.

Having for some time past made a great many experiments with achromatic eye-pieces of doubles, triples, and other forms, I may sum up my results by saying that I had not succeeded in producing any combination whose defining power surpassed that of the Huyghenian.

When I saw the increase of defining power given by the compensating eye-pieces, I determined to reopen my investigations.

The theoretical action of the Huyghenian eye-piece requires that an over-corrected image should be received by the field-lens, the over-correction to be of such an extent that the under-corrected field-lens of the eye-piece is not able to neutralize it, but leaves it still over-corrected by an amount equal to the under-correction of the eye-lens. I must say that my surprise was great on obtaining better definition with Prof. Abbe's over-corrected eye-pieces used in conjunction with the supposed over-corrected ordinary achromatic objectives. I concluded, therefore, that by reducing the under-correction of the eye-lens of the Huyghenian eye-piece better definition would be secured.

We know that in the formula for aberration—

$$- \Delta f : \frac{y^2}{f} = \frac{\mu - 1}{2\mu^2} \left\{ \frac{1}{r^3} + \left(\frac{\mu + 1}{f} - \frac{1}{r'} \right) \left(\frac{1}{f} - \frac{1}{r'} \right)^2 \right\} f^3$$

and where $f =$ principal focus; $y =$ semi-aperture; $\mu =$ ref. index and $r, r',=$ radii; if we put $r = \infty$, and $- r' = \frac{f}{2}$ we get the aberration for a plano-convex lens having its convex side to the focus; in other words, the eye-lens of a Huyghenian eye-piece, viz. $\Delta f = - \frac{9}{2} \frac{y^2}{f}$.

If, however, we invert the lens, $\Delta f = - \frac{7}{6} \frac{y^2}{f}$ or about 1/4 of what it was before. I therefore concluded that by the inversion of the eye-lens there would be an improvement in the definition though a loss in the size of the field.

In practice I found these conclusions verified. The best results were obtained by achromatizing the eye-lens, i. e. by making it of a biconvex and a plano-concave, with its convex side towards the eye. The aperture in the diaphragm was reduced until the diameter of the field was equal to that of the Abbe compensating eye-piece.

This eye-piece, with the achromatized eye-lens, gives the sharpest images I have seen. It works perfectly well with the 24 mm. and 3 mm. Zeiss apochromatic objectives.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Fertilization and Segmentation of the Animal Ovum.‡—Drs. O. and R. Hertwig have made a series of experiments on animal ova with the object of affecting, by chemical, thermal, and mechanical agencies, (1) fertilization, (2) the process of the internal phenomena of fertilization, and (3) segmentation.

In considering the mode of action of the reagents used, attention must be given to the degree of concentration of the chemical reagents, and the differences in the temperature applied; the time, also, during which the modifying influence is allowed to exert itself is important.

The movements of spermatozoa were found to be stopped by slight doses of quinine or chloral, but as, on addition of fresh water, they recovered themselves it is clear they were not killed, but only had their contractility affected; their reproductive power was not impaired. Morphia, moderately strong solutions of strychnine, and nicotine seem to exert no influence on spermatozoa; a very strong solution of nicotine, acting for an hour, appears to produce changes in the spermatozoa.

The formation of the fertilization-sphere, or that elevation of the ovarian protoplasm which marks the point of entrance of the spermatozoa, appears to be affected by chloral or quinine; slight heating (up to 31° C.) produces at first an increase in the size of the sphere; higher temperatures and greater length of exposure have the same effect as quinine. Morphia, strychnine, and nicotine have no effect.

As to the effect of reagents on segmentation, it was found that 0·6 per cent. solution of morphia does not affect the ova, and that they will continue to divide for a day in a 1 per cent. solution; strychnine and nicotine have no, but quinine, chloral, and heat have a distinctly weakening effect. Eggs placed in water of 32° C. for ten minutes never completely regain their power of segmentation.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 120–241, 477–510 (5 pls.).

The changes produced by quinine and chloral on dividing ova affect the nucleus as well as the protoplasm, and the phenomena of karyokinesis may be seen to be disturbed by these reagents.

It would seem to be certain that the most important matter is the diminution of the contractile power of the reproductive elements, and this is proved not only by the quiescence of the spermatozoa, but by the stoppage of segmentation and the retrograde metamorphosis which is undergone by the nucleus.

If the view be correct that quinine and chloral have weakening, and nicotine and strychnine slightly stimulating effects on the contractility of the egg, it is clear that we have fresh means for investigating the significance of the formation of rays in the interior of the ovum. The authors regard the sperm-nucleus and the ends of the segmentation-nucleus as centres of stimuli which have an effect on the protoplasm. It is natural that the homogeneous constituents of the protoplasm, which are the seat of contractility, should stream towards the point of stimulation, and they produce an aggregation of elements; but it is further probable that the movement should take place in a radial manner, and should thus exercise a directive influence on the passive parts—the granules. But this directive influence can only be exercised so long as the movement which causes it is energetic; if it is slowed by any agent, the granules would retain their position, and the homogeneous protoplasm would alone be collected around the nucleus.

Armed by the knowledge of abnormal phenomena which they have acquired, the Drs. Hertwig regard the ray-figures given by Carnoy as pathological conditions. Increased irritability, weakening, and polyspermy are not the only changes which may be caused in eggs by external influences; in addition, there are changes in the chemical composition of the substances forming the egg, and that even before the approach of death.

In dealing with the process of fertilization, it is pointed out that abnormal fertilization may occur when spermatozoa of another species come in contact with the egg, or if many spermatozoa of the same species enter the egg (polyspermy). In inquiring as to the arrangements which prevent abnormal fertilization, the first point of importance is this: no peculiar properties can be observed in the egg which can be regarded as aiding in normal fertilization; spermatozoa appear to have the tendency to enter any eggs, and in any quantities. Few experiments have been made on this point, but it has been observed that eggs which were sufficiently under the influence of chloroform showed no increased tendency to bastardation. It would, therefore, appear that the chemical bodies which aid fertilization offer no assistance to bastardation.

Polyspermy can be brought about by chemical, thermal, and mechanical agencies, and the number of spermatozoa increases with the intensity and duration of the agents used; with heating, however, there is a point at which fertilization stops.

Two hypotheses suggest themselves as explaining how polyspermy is ordinarily prevented; one is that the fertilizing spermatozoon causes a contraction of the egg-cell, which prevents the entrance of other spermatozoa: and the other is that the spermatozoon stimulates the ovum to produce a firm membrane—the vitelline—through which other spermatozoa cannot make their way. The former of these may be dismissed now that we know that polyspermy may be aided by reagents which increase the contractility of the egg; the latter has the support of Fol, and seems to find support from some experiments made by the writers. If ova be placed in sea-water with which chloroform has been shaken up, the membrane appears

exactly as it does after fertilization, and such ova cannot be fertilized by spermatozoa.

In investigating this matter a little further it is necessary to distinguish the two peculiarities of protoplasm which are exhibited in the formation of the yolk-membrane; these are its secretory activity and its irritability. The egg must have a minimum stimulus to produce its membrane, and this minimum stimulus is, in normal eggs, the entrance of one spermatozoon.

We now pass to the changes in the conjugation of the sexual nuclei and the internal processes of fertilization. The experiments which have been made show that, with the aid of reagents, the copulation of the nuclei may be hindered or stopped. It seems to be certain that nuclei provided with all the vital properties which are necessary for further development only appear when the substances are thoroughly impregnated by the male and female nuclei; however, even when the nuclei do not unite, they have properties which they had not originally; the male and female nucleus are both capable of undergoing fibrous differentiation and forming chromatic loops and a chromatic filament, even if they are kept separate from one another. If portions of ova without nuclei are separated from the rest of their cell, they may be penetrated by spermatozoa which in them form spindles; or, in more general terms, we may say that the protoplasm of the egg alone is able to give the male nucleus the power of forming spindles.

In ova, however, which possess germinal vesicles, the spermatozoa undergo no changes and are not acted upon by the protoplasm of the egg; if the directive spindle is in the process of formation the heads of the spermatozoa remain unaltered, but there is a slight radiation of the protoplasm. No exchange of substance takes place between the male nucleus and the ovarian protoplasm until after the formation of the first directive corpuscle.

In observing the fate of the female nucleus the authors found three classes of results: the ovarian nucleus copulates with only one male nucleus, and in division only one spindle is formed; the ovarian nucleus copulates with two or more male nuclei, and produces four-poled or many-poled karyokinetic figures; or the ovarian nucleus remains by itself, and by the imbibition of fluid increases rapidly in size. The last phenomenon is common in proportion to the number of spermatozoa that enter the egg.

Two or three male nuclei may certainly fuse with the female nucleus, so that the capacity of the female nucleus for receiving spermatic nuclei appears to be considerable, and to last even after several copulations have taken place. The male nuclei undergo fibrous differentiation, and become converted into small spindles, which in course of time also divide; nothing, however, is yet known as to the fate of these products of division.

The last point to be noticed concerns the variations in the phenomena of cleavage. In their experiments, the Drs. Hertwig altered the process of cleavage in three ways; the eggs, after fertilization, were treated with reagents, or they were fertilized by several spermatozoa, or the completion of fertilization was hindered. In the normal stages of cleavage two processes go on simultaneously in the nucleus; one is an increase in size, and the other is karyokinesis. The latter, but not the former, is affected by quinine and chloral; similar changes may be seen in polyspermy. When this last is brought about by the aid of morphia, strychnine, or nicotine, or, in other words, by reagents which do not of themselves influence the process of division, there appear tetraster or polyaster figures, which are to be explained not by the action of the reagents, but by polyspermy. There can be no doubt that fertilization by two spermatozoa leads to the formation of tetrasters; but all tetrasters must not be referred to this cause, as

the result may be sometimes due to nothing else than a certain increase in the size of the nucleus. The authors have made numerous observations with especial reference to the formation of double monsters, and they see no reason to suppose that these are to be regarded as due to the fertilization of one egg by two spermatozoa.

Human Ovum.*—Dr. W. Nagel communicates a description of the human ovum, in regard to which there has been a lack of precise information. His material was obtained from ovaries removed in operations. Healthy follicles were isolated and examined, and in other cases sectioned *in situ*.

The zona pellucida is very distinct, and is separated by an extremely fine "perivitelline space" (apparently containing clear fluid) from the vitellus. Within this is the narrow clear "cortical layer" of the vitellus, then a somewhat broader finely granular "protoplasmic zone," then the "deutoplasmic portion" with abundant globules, more abundant and less refractive than in the ova of domestic mammals.

The nucleus is round, clear, double-contoured, always excentric, and in the protoplasmic zone. There is a distinct nuclear network. The nucleolus exhibits amœboid movements.

The corona (epithelium of ovum) was always well developed on ripe eggs. The diameter of the ripe ova varied from 124–128 μ. The various zones vary somewhat in different regions. The nucleus measured 19–20 μ.

In the ovaries of new-born subjects, besides the usual primordial follicles, larger follicles were observed (Waldeyer-Slavjansky). In these, sections revealed normal ova, and the author does not therefore regard the presence of these large follicles as indicative of incipient cyst-formation.

In development, the protoplasm and nucleus increase in size, the follicular cells multiply, the deutoplasm is formed, the nucleus is pushed to the side, and a zona pellucida begins to appear.

Fertilization of Ovum of Lamprey.†—Herr A. A. Böhm has studied the phenomena of fertilization in the ovum of *Petromyzon planeri*, and gives the following summary of his results:—

(1) The substance of the germinal vesicles spreads out on the surface of the ovum at the animal pole to form the pole-plasma.

(2) During impregnation, *pari passu* with the formation of the vitelline membrane, the pole plasma is covered with a fresh, thick, folded membrane. This concentrates the fertilization to a limited area, and disappears after fertilization is accomplished.

(3) The pole-plasma with the elements concerned in fertilization is retracted inwards, but remains connected with the surface of a thin protoplasmic strand which lies in the axis of the ovum in the plane of the first meridional segmentation.

(4) The male and female nuclei fall into portions (spermato- and karyomerites).

(5) For a while these can be microchemically distinguished.

(6) The merites do not at first intermingle, but form two closely apposed groups. The plane separating these two groups coincides with a meridian of the ovum.

(7) Each merite consists of a body with little chromatin and a body rich in chromatin (the microsome).

(8) The final nucleus of segmentation arises by the fusion of the

* SB. K. Preuss. Akad. Berlin, 1887, pp. 759–61.

† SB. Bayer. Akad. Wiss. München, 1887, pp. 53–62.

spermato- and karyo-merites into a homogeneous mass. The included microsomata are no longer distinguishable as regards their origin.

(9) From these microsomata the chromatic portion of the karyokinetic figure is formed.

Intra-Ovarian Egg of some Osseous Fishes.*—Dr. R. Scharff has examined the ova or ovaries of several osseous fishes, among which the gurnard was a very suitable object of investigation. In speaking of the nucleus and its changes in the smaller ova, the author announces his agreement with the opinion of Dr. Will, that no morphological significance is to be attached to the nucleoli; they must be regarded as large masses of chromatic substance. With regard to the dark and light-coloured protoplasm, it is suggested that the dark central protoplasm owes its origin to the nucleus. The egg-membrane, or more or less thick layer which surrounds the egg, and which has been called by seven different names, of which "zona radiata" is here preferred, is, in the gurnard, often granular; within is a much broader layer, which, by its semifluid condition, may be distinguished from the much firmer or elastic zona radiata. In the ripe ova the zonoid layer entirely disappears.

The follicular layer of the ripe gurnard's egg consists of a layer of closely set cells. With regard to its development, the author's observations are incomplete, but he is inclined to think that it owes its origin to the connective tissue; at any rate it is formed before an egg-membrane can be seen.

Development of Osseous Fishes.†—In his first chapter Dr. J. H. List deals with the morphological results which he has obtained by the study of the Labridæ, a family which is well represented in the Adriatic.

The ripe ovum of *Crenilabrus tinca*, before fertilization, has a diameter of about 0·9 mm.; the zona pellucida has an interesting structure, for it consists of two layers. Of these, the outer is formed of regular six-sided prisms, and the inner, which is more homogeneous, exhibits merely a feeble parallel striation. The germinal substance is only incompletely differentiated from the yolk in *C. tinca*, but in *C. pavo* it forms a clearer layer round the yolk. On the whole, the arrangement of the germinal substance in the ovum of *Crenilabrus* exhibits a close resemblance to that of the herring, as described by Prof. Kuppfer; there are no signs of any germinal processes extending into the yolk.

The spermatozoa of *C. pavo* are 18 μ long, of which the tail is 14 μ; at the moment when the spermatozoon is swallowed by the micropylar canal the inner part of the latter is blocked by a feebly refractive mass, and by this means the entrance of other spermatozoa is prevented. Seven minutes after the entrance of the spermatozoa into the egg the directive corpuscle was seen projecting from the funnel-shaped entrance of the micropyle, and within half an hour was extruded. The ovarian contents next underwent contraction, and within three-quarters of an hour after impregnation a clear space could be noticed between the zona pellucida and the contents; this space was filled by a colourless fluid, which was probably partly squeezed out from the yolk. The contraction of the germinal substance ceases after about an hour and a half; and the first segmentation groove appears. This is somewhat excentric. Almost simultaneously an equatorial groove appears at right angles to the first. From the next series of changes it became clear that the form of the nutrient yolk is dependent on the direction of the

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 53–74 (1 pl.).
† Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 595–645 (3 pls.).

greatest growth-energy in the germinal substance; this energy seems to depend on the direction of the planes of segmentation.

Six hours after impregnation the blastodisc is formed, and lies flattened on the now completely spherical yolk; its outer surface is bounded by a layer of flattened cells. Seven hours and a quarter after impregnation nuclei appear in the part of the intermediate layer which is visible around the margin of the blastodisc; these group themselves in almost concentric rows round this margin, and the rows are arranged in such a way that an interspace of the succeeding row corresponds to every nucleus. After pointing out the views held by previous writers with regard to these bodies, the author states that he himself has observed clear vesicular nuclei appearing round the edge of the blastodisc, and has found that they were derived from the nuclei of its marginal cells. Nuclear figures were never observed, but the author distinctly saw these nuclei constricted off from those of the marginal cells; the newly-formed structures increase in size rapidly, and soon become disposed in rows. As to the significance of the periblast the author hesitates to form a judgment, but the view that we have to do with a conversion into nutrient material does not recommend itself to him.

In his second chapter the author deals with the formation of the embryo, and compares his results with those of other embryologists who have studied the development of fishes; in the third chapter the development of the eyes and ears, of the central nervous system and notochord, of the intestinal tract and other parts of the body is described.

Polar Bodies and Theory of Heredity.*—Prof. A. Weismann publishes a confirmation and *résumé* of his previous conclusions which have been embodied in various papers since 1881. He regards it as a firmly established and fundamental fact that all animal eggs which demand fertilization give off two polar bodies as preparation for embryonic development, while parthenogenetic eggs never extrude more than one. This fact, he says, dismisses any merely morphological explanation of the precedents. If it had no physiological signification, parthenogenetic eggs could retain the portion of nucleus separated by a second division, no better than those which demand fertilization.

Dr. Weismann's opinion is as follows:—The first polar body represents the extrusion, after maturity is reached, of the too active protoplasm of the nucleus; the second is the extrusion of part of the germ-plasm itself, through which the quantity of original protoplasm from the parent is reduced by one-half. A similar reduction must take place in the male germinal cell, but it is impossible as yet to show this definitely from the observed histology of spermatogenesis.

Parthenogenesis occurs when the whole of the germ-plasm from the parent is retained within the egg-cell. Sexual reproduction demands that half the germ-plasm be extruded from the egg, so that the remaining half may again reach the required size by uniting with the sperm-nucleus.

In both cases the beginning of development depends on the presence of a certain, and indeed of the same quantity of germ-plasm. The fertilized egg gains this by the addition of the sperm-nucleus, and the commencement of embryonic change follows right on the heels of fertilization. The parthenogenetic egg contains from the first the necessary amount of germ-plasm, and it becomes active as soon as the extrusion of the single polar body has freed the egg from the "oogenetic" nuclear plasm.

* Weismann, A., 'Ueber die Richtungskörper, und über ihre Bedeutung für die Vererbung,' 1887.

In regard to the theory of heredity, Dr. Weismann concludes that the germinal cells of a single individual do not embody similar hereditary tendencies, but that in this relation they are all different, and that no two provide quite the same combination of tendencies. This he thinks explains the long-recognized differences between the children of the same father and mother; and he adds that the deeper import of this arrangement must be seen in freely-conditioned ever-newly-blending individual variability, for sexual reproduction appears more and more in the light of an arrangement by which an ever-changing wealth of individual conformations is handed on.

β. Histology.*

Theory of Cell-division.†—Herr G. Platner has been led by the results of his study of karyokinesis in Lepidoptera to seek to lay the foundations at least of a theory of cell-division. He has tackled the problem of cellular mechanics, and finds the condition of nuclear division to be in part at least streaming of the protoplasm, such as is familiar in pseudopodia and Myxomycetes. The phenomena of karyokinesis can be explained as the results either (1) of chemical processes influencing the cellular substance, or (2) of protoplasmic movements due to the above or to external influences, or (3) of unknown molecular and attractive forces.

According to Platner, the separation of the daughter elements on the dislocation of the equatorial plate (Flemming's metakinesis) is the result of a circulating stream. The form and position of the nuclear spindle are mechanically conditioned by fluid movements within the latter, and radiating from the poles. The appearance of the primary asters depends upon the direction in which the stream of nutritive fluid circulates through the cell, and the spindle developes at right angles to this. The same causes effect the movements of the nucleus. The formation of the nuclear coil, and the disposition of the equatorial plate is the result of plasmic streams penetrating the nucleus in given direction. The achromatic substance is the active element in karyokinesis. The division of the protoplasm is a purely mechanical process.

Synthetic Processes in Living Cells.‡—Fräulein J. Brinck and Herr H. Kronecker submit the results of numerous observations on the physiological relations between living cells and various substances. Their experiments led to the following conclusions:—(1) Serum-albumin is more surely characterized by its nutritive relation to muscle, than by physical and chemical reactions; (2) stomachic peptones are still albuminoids in the physiological sense, pancreatic peptones are not; (3) Stomachic peptones are reconverted into serum-albumin by many kinds of living cells; (4) a bacillus has the same useful property of forming serum-albumin from stomachic peptones; (5) pathogenic bacilli have a destructive influence.

Structure and Distribution of Striped and Unstriped Muscle in the Animal Kingdom.§—Mr. C. F. Marshall has endeavoured to trace the distribution of the intracellular network of the striped muscle-fibre in the animal kingdom. It is pointed out that the striation of muscle must not be confounded with the transversely striated appearance which is caused by the corrugation of the outline of the fibre, and which is probably due to a state of over-contraction.

* This section is limited to papers relating to Cells and Fibres.

† Internat. Monatschrift f. Anat. u. Histol., iii. (1886) p. 10. Naturforscher, xx. (1887) p. 315.

‡ Archiv. f. Anat. u. Physiol., 1887, pp. 347–9.

§ Quart. Journ. Micr. Sci., xxviii. (1887) pp. 75–107 (1 pl.).

The vacuolated condition seen in the protoplasm of various Protozoa may, perhaps, indicate the starting-point of the differentiation of an intracellular network, or, in other words, the differentiation of the cell into firmer and less dense portions, the former of which takes on the form of a network; the highly contractile fibril of *Vorticella* shows no trace of the presence of fibrils, and appears to be simply undifferentiated protoplasm.

Of the Cœlenterata *Hydra* was found to have a network in the body of the ectoderm cells, but this was not continued into the "muscular process"; *Aurelia* has striped muscles in which the distinct transverse striation is due to the presence of a network which is similar in all respects to the network described by Retzius and Melland in striped muscle; in *Actinia* the muscle showed no trace of any intracellular network or of any fibrillation. Here, then, as with the Echinodermata, in which there is no trace of a network, the author agrees with Dr. Hamann.

Among worms, the leech and the earthworm were examined; in the former the muscle-fibres are very peculiar, consisting of an outer clear portion and a central granular part; no distinct fibrils could be detected. In the earthworm the muscle is found to contain large elongated cells with longitudinal lines, which under a 1/10 immersion objective present a dotted appearance; the dots, however, are quite irregular, and do not extend into the body of the cell.

In the Mollusca, the limpet was found to have the network of striped muscle in its muscle, and the same was found in the muscle of the snail's odontophore, and in the adductor muscle of *Pecten*, which differs from most of its class by using that muscle to propel itself through the water. Striped muscle was found in various Arthropods, and in the muscular bands of *Salpa*.

As to the Vertebrata, it is to be noted that the striation of cardiac muscle appears to be due to an intracellular network similar to that of ordinary striped muscle.

If we resume these facts, we find that striped muscle is ordinarily associated with energetic animals or movements; the presence of such in some sluggish animals, such as certain insects, may be supposed to be due to inheritance. We find that (1) an intracellular network of a definite character is present in the fibre of striped muscle throughout the animal kingdom. (2) This network is developed where rapid and frequent movements have to be performed. (3) The striped muscle-fibre consists of sarcolemma, network, and sarcous substance; and, so far as at present determined, there is no other structure present in the fibre (except muscle-corpuscles and nerve-endings). With regard to the mode of action of striped muscular fibre, Mr. Marshall is of opinion that its construction is due to the active contraction of the longitudinal bars of the network, and that the transverse networks are probably passively elastic, and cause by their rebound relaxation of the fibre. It is possible that the transverse networks and the muscle-corpuscles with which they are said to be continuous, furnish paths by which the nervous impulse is conveyed from the nerve-ending to the longitudinal bars. As to the contraction of unstriped muscle, it is probably due to the active contraction of its longitudinal fibrils, when such, as in vertebrate muscle, are present; when they are absent the contraction must be referred to the whole protoplasm of the cell, for there is no special part differentiated to perform the function.

The author is aware of two objections to his suggested explanation; the first affects the supposed difference between the longitudinal and transverse bars of the same network; but it is possible that the latter are really, as Retzius thinks, direct processes of the muscle-corpuscles. The

second objection is that the theory attributes the function of contraction to the network which forms much less of the bulk of the fibre than does the sarcous substance; but the latter may have to perform thermogenic functions which must absorb a far greater amount of its energy than does the contractile function.

Comparative Size of Blood-corpuscles in Man and Domestic Animals.*—Miss F. Detmers considers that she has established, by a series of measurements, that there can be no question but that the blood of human beings can readily be distinguished from that of such animals as the mule, cat, calf, and horse, and more readily from cattle, sheep, and pigs.

Blood-corpuscles of the Cyclostomata.†—Prof. D'Arcy W. Thompson traverses the generalization found in many text-books that the red blood-corpuscles of Cyclostomata are round and not oval. He finds, as indeed did J. Müller, that the red corpuscles of *Myxine* are large and oval, being ·025–·028 mm. in length, about ·01 mm. in breadth, and about ·003 mm. in thickness. In *Petromyzon marinus*, the red blood-corpuscles are circular, and about ·013 to ·014 mm. in diameter, and the nuclei are excentric and stain very slowly and feebly with magenta, whereas in *Myxine* they are central and stain easily. Shipley, who has recently stated that the red corpuscles of the ammocœte are oval, confirms his statement; this noteworthy difference between the larval and adult forms recalls the differences in the red corpuscles of the tadpole and the frog.

The white blood-corpuscles of *Myxine* are nearly or sometimes quite as numerous as the red, are of about the same size as in man, and have a very large granular nucleus. In *P. marinus* they are three or four times as numerous as the red, their nuclei are small and stain well; forms transitional in shape and size to the red corpuscles may be recognized.

Hæmatocytes.‡—M. Fokker gives a somewhat astounding account of some observations on the behaviour of blood. He has previously sought to show that protoplasm from a healthy organism, placed in a nutritive medium, with the exclusion of microbes, may remain alive and cause fermentations. He now seeks to prove that such protoplasm may develope a vegetative form, different from that exhibited in the body of the animal from which it was taken.

Some blood was taken with all necessary precautions from a healthy animal, placed in distilled sterilized water, and kept at the ordinary temperature, and at 37° C. It remained alive, but above 37° died.

If the distilled water be replaced by a very weak solution of nutritive salts, or even by drinking water, the blood remains at the ordinary temperature alive, for a year even. But at 37°, and above, a sediment is formed. The amorphous molecules in the debris increase gradually and form small vesicles which may attain the dimensions of the blood-corpuscles! These little knobs M. Fokker calls hæmatocytes, and the process is designated heterogenesis. These vesicles have nothing in common with any elements previously described in the blood. They may be stained with iodine, or with methyl-violet, fuchsine, and eosin. They have often a regular form, and their size is very variable. They do not multiply in cultures.

That they are really alive is demonstrated by their growth as observed under the Microscope, and by the fact that they do not develope in the absence of oxygen.

* St. Louis Med. and Surg. Journ., liii. (1887) pp. 209–15.
† Ann. and Mag. Nat. Hist., xx. (1887) pp. 231–3.
‡ Comptes Rendus, cv. (1887) pp. 353–6.

He kept dilutions of blood in drinking water at the ordinary temperature, and others in saline solution at 37°. At the end of a year in the one case, and of three months in the other, he placed the dilutions in a temperature of 52°. By the end of 24 hours both dilutions had gone in for almost normal heterogenesis.

γ. General.*

Phosphorescence.†—On this subject, Dr. C. F. W. Krukenberg reviews the literature up to the present time, referring to Ehrenberg, Milne-Edwards, Panceri, Pflüger, and other investigators. He then gives in detail, and at considerable length, the results of his own recent experiments and observations in three special directions. The first and second of these are the cases of *Pteroides griseum*, and *Agaricus* (*Crepidotus*) *olearius*. The third deals with the luminosity of the Red Sea, and includes some very graphic descriptions of phenomena observed. The experiments, which are described at length and also given together in tabular form, consisted principally in watching the light-producing organisms in very widely varied circumstances as to medium and temperature, and also in treating them with various anæsthetics and other chemical reagents.

Dr. Krukenberg emphasizes as the most general and important conclusion from the investigations, and that likely to afford most guidance in future research, that, in both animals and plants, whenever phosphorescence is truly present, it is caused by certain vital processes being applied to the production of light in a manner exactly parallel to those in which heat and electricity are produced in living beings.

Function of Otoliths.‡—Prof. T. W. Engelmann made some observations on the functions of the so-called otoliths in the sensory bodies of Ctenophores previous to the appearance of Dr. Delage's paper. He thinks what he has seen confirms the views of the French naturalist, and hopes that the investigation will be carried further. The author regards the so-called otoliths which are placed at the aboral pole of the body of Ctenophores as an apparatus for preserving the equilibrium of the body. After a reference to the discoveries of Chun, he concludes that there is no reason for adhering to the old view that the bodies in question have any auditory function, and he thinks it clear that the object of the otolith is, by means of the ctenophoral plates, to keep the primary axis of the body in its normal upright position. When this axis is vertical, the otolith presses with equal force on the four pinnate bands which extend up to it; if the axis inclines at all it presses more strongly on the corresponding band, and less on the others. This pressure is, by means of the cellular cords connected with the band, which are nervous in function, conveyed to the ctenophoral plates, and thus a compensating movement of the body is brought about, and the body returns to its normal vertical condition. We have here a reflex process of the most elementary kind—a process of regulation in which it is not necessary for either conscious sensation or will to take any part, but which may be altogether mechanical.

Reference is made to a number of illustrative and instructive facts, such as the very general presence of otoliths in freely moving animals, their absence in many fixed or slowly creeping forms, and their loss in fixed forms which have large otoliths in their freely moving early stages; in many cases (Mollusca) they are imbedded in soft inelastic tissue which

* This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

† Vergleichend-physiologische Studien, iv. (1887) pp. 77–142.

‡ Zool. Anzeig., x. (1887) pp. 439–44.

is by no means adapted to carrying waves of sound; they are very generally connected with cellular outgrowths which are necessarily pressed upon when the equilibrium of the body is disturbed. These considerations may be extended to the Vertebrata, and it is suggested that the cristæ acousticæ of the ear with which no otoliths are connected may perform the acoustic functions of the ear, while the maculæ acousticæ have an equilibrating function. The well-known observation of Hensen as to the casting of the otoliths in certain Crustacea seems to be of great significance in connection with the real function of these organs.

B. INVERTEBRATA.

Pericardial Gland of Opisthobranchs and Annelids.*—Prof. C. Grobben endeavours to demonstrate the homology of the pericardial gland of Molluscs with structures which are found in Annelids. He points out that the pericardial gland of Molluscs is a local glandular development of the epithelium of the secondary cœlom, as the pericardial space must be regarded as being.

Similar glandular differentiations of the cœlomic epithelium are to be seen in the chlorogogue cells of many Annelids, and they too are found on the blood-vessels. In some cases these bodies form special organs; they are best developed in the well-known tubular contractile appendages of the dorsal vessel of the Lumbriculidæ, and the structures described by Claparède in *Lumbricus* as best developed on the vascular loops of the septa are bodies of the same kind. The excretory function of the pericardial gland and epithelium is best shown in the Mollusca; these are cells heavily laden with concretions which can hardly make their way to the exterior save by the kidney; similar bodies escape outwards by the nephridia in Annelids.

Singular Parasite on Firola.†—Prof. H. Ludwig has a note on the remarkable parasite in *Firola* (*Trichoelina paradoxa*), lately described by Dr. J. Barrois,‡ showing that it is nothing more than the separate capitulum of a gemmæform pedicellaria, and almost certainly of *Sphærechinus granularis*.§

Mollusca.

Structure of Branchia of Prosobranchiate Gastropoda.‖—M. F. Bernard has investigated the structure of the gill of various prosobranchiate gastropods. He finds that the epithelium always consists of two kinds of elements—columnar ciliated cells, inserted on a basilar membrane by a narrow prolongation which is sometimes branched, and muciparous cells arranged in small scattered groups. The basilar membrane does not contain any cartilage; what has been regarded as such is a thickening formed of superposed layers, and contains no trace of cells. Between the two layers of the membrane are stellate cells, with anastomosing prolongations; these, which may be isolated or connected, form the ordinary connective tissue of the lacunæ. There are longitudinal and transverse muscular fibres.

Although the author has been able to reproduce the appearances figured recently by M. Wegmann, he does not believe that the "vessels" are anything more than portions of the lacunæ where the connective tissue is scattered, and where therefore the injection circulates easily. The space contained by the double basilar membrane is only a simple diverticulum of the general lacuna which extends between the two folds of the mantle.

* Zool. Anzeig., x. (1887) pp. 479–81. † Ibid., pp. 296–8.

‡ See this Journal, *ante*, p. 373.

§ This note, owing to a misprint, was wrongly placed at p. 598, and *Trichodina* was printed for *Trichoelina*. ‖ Comptes Rendus, cv. (1887) pp. 316–8.

Structure of False Gills of Pectinibranch Prosobranchs.*—M. F. Bernard has examined the so-called false gills in *Cassis*, *Buccinum*, *Nassa*, *Murex*, and various other genera of pectinibranch gastropods. He thinks we must consider the organ as formed of a series of folds of the internal layer of the mantle. The space in the interior of each lamella is a lacuna which communicates by a cleft with the large intrapallial lacuna which extends under the false gill. The afferent branchial canal which extends between this organ and the true gill is well provided with muscular walls on the side of the latter; but on the side of the false gill it is only separated from the intrapallial lacuna by a spongy connective tissue perforated by a large number of orifices by which the blood of the false gill passes to the canal and thence to the heart; the canal is not therefore strictly a vessel.

A principal nerve, sometimes formed of several anastomosing bundles, penetrates into each lamella where it gives off ramifications; among these are found multipolar connective cells identical with those found in the true gills. The nerve has been easily studied by the aid of the double chloride of ruthenium and potassium (or ammonium), which was found to be more useful than hyperruthenic acid. By its means the fibres may be seen to become gradually isolated and to terminate in large rods placed among epithelial cells.

The epithelium contains mucous cells, ciliated cells as in the gill, and elements which end in a pretty long delicate rod. The basilar membrane presents crests, folds, and thickenings directed along the courses of the nervous ramifications, but there are never the double longitudinal thickenings which are characteristic of the branchial lamellæ.

The muscular fibres are numerous and varied, and may, by their combination, diminish the size of the blood-sinus, but their irregular arrangement, and the presence of connective elements in the interior of the sinus prevent our regarding the latter as a vessel. In some Strombidæ and in *Pterocera*, the nerve bifurcates several times and branches in a fanlike fashion. On the whole, the author regards the false gill as a sensory organ formed by folds of the mantle in which there are a number of nerve formations. In some of the higher forms the connective elements are so arranged as to form a respiratory apparatus no less differentiated than the gill-lamellæ themselves.

Renal Organs of German Prosobranchiata.†—Herr G. Wolff has investigated the structure of the renal organs of *Paludina vivipara*, *Bithynia tentaculata*, and *Valvata piscinalis*. He has been able to detect the internal orifice of the organ, though it is considerably degenerate. The ductus renopericardialis appears to be least atrophied in *Valvata*, which so far stands nearest to the pulmonate gastropods; the well-developed cilia found on its epithelial cells are wanting from *Paludina* and *Bithynia*. In *P. vivipara* the duct is placed at the point where the renal organ opens into what Leydig called the water-reservoir, and it is clear that the pericardial orifice of the kidney is physiologically connected with the opening of the kidney into the reservoir, since the muscular fibres which surround it are connected with the sphincter which surrounds the other opening of the kidney. The glandular organ of *Bithynia* has two openings which lead to the exterior, one superior, and one inferior. The pericardial orifice is placed near the upper of these.

Oogenesis of Chiton.‡—M. P. Garnault has studied the development of the ovum and its follicle in *Chiton cinereus* and *Chiton fascicularis*, and

* Comptes Rendus, cv. (1887) pp. 383–5. † Zool. Anzeig., x. (1887) p. 317.
‡ Comptes Rendus, cv. (1887) pp. 621–3.

has been led to results somewhat different from those of Ihering and Sabatier.

According to Sabatier, the ova are formed at the expense of the connective cells of the ovarian wall. As they grow they raise the connective padding (feutrage) which surrounds them. They are covered by a non-cellular membrane. Nuclei arise within the protoplasm and shift to the periphery.

M. Garnault maintains that the ova arise from a germinal epithelium, that the follicle consists distinctly of cells homologous with those which form ova. The internal corpuscles said to move to the periphery are not really nuclear, but only intra-vitelline, albuminoid bodies.

The stalked ovum exhibits on its surface and in relation to each of the follicular cells, protrusions of the vitellus, especially marked in *C. cinereus.* The summit of each vitelline expansion is in close association with the nucleus of the follicular cell. Soon these protrusions retract, dragging with them the nucleated portions of the several follicular cells. The stalk degenerates, and before the final rupture is represented only by a membranous shred. The point of rupture corresponds to the micropylar orifice. The follicular membrane becomes thickened and depressed; it ought not to be spoken of as *coque* or *chorion.* The final non-cellular membrane, described by Sabatier, does not exist.

Nephridia and "Liver" of Patella vulgata.*—Dr. A. B. Griffiths has made a chemical examination of the nephridia of the common limpet, and has been able to isolate uric acid, and to obtain successfully the "murexide test." He finds that, with regard to the "liver," its secretion converts starch into glucose-sugar, as proved by the use of Fehling's solution; the secretion produces an emulsion with oils and fats, yielding subsequently fatty acids and glycerol; when a few drops of the secretion were examined with chemical reagents under the Microscope a brown deposit was obtained with a solution of iodine in potassium iodide; with concentrated nitric acid there was a yellow coloration, due to the formation of xantho-proteic acid; both these reactions show the presence of albumin in the secretion of this organ.

On the soluble ferment being isolated by the method of Wittich and Kistiakowsky it was found to convert fibrin into leucin and tyrosin, no glycocholic or taurocholic acid could be detected, and no glycogen was found in the organ or its secretion; but this secretion does contain leucin and tyrosin. The author concludes, therefore, that the "liver" of the limpet has a similar function to the pancreas of the Vertebrata.

Morphology of Epipodium of Rhipidoglossate Gastropoda.†—M. P. Pelseneer, in consideration of the very various opinions that have been held as to the morphology of the epipodium in rhipidoglossate Gasteropods, has reinvestigated the anatomy of *Trochus.* He finds that in it each pedal cord has an external longitudinal groove, but it is, nevertheless, not composed of two nerves, the peculiar conformation being due not to the fusion of two different centres, but to the commencing separation of a single one; this specialization is due to the development of the epipodium. The pleural ganglion lies at the commencement of the pedal cord, where the visceral commissure commences to be formed. M. Pelseneer finds, therefore, that the pedal cord of *Trochus* is single, and that the epipodium is a part of the foot; it would, indeed, be hard to conclude otherwise, when we examine a *Trochus* externally, for it may then be seen that the epipodium has no

* Proc. Roy. Soc. Lond., xlii. (1887) pp. 392–4.
† Comptes Rendus, cv. (1887) pp. 578–80.

relation to the mantle, but is placed quite beneath the foot, and surrounds the operculum, as to the pedal nature of which there is no doubt.

Byssus Gland of Lamellibranchs.*—Herr L. Reichel is of opinion that the byssus of Lamellibranchs is a cuticular structure, the roots of which are formed in the byssus-cavity, and the filaments in the groove of the foot. The glandular cells which should be present, were the secretion-theory correct, are never to be found. The groove can, by the approximation of its edges, be converted into a complete canal, the lumen of which is semilunar in shape. The epithelium of the canal and of the cleft continuous with it are distinguished by two characters: in the latter the cilia are placed on a cell-membrane, which, in cross-section, has a distinctly double contour; in the former there is but a single line between the byssus-substance and the epithelial cells; each cell of the canal has only one process, while those of the cleft have each several cilia. Other objections are raised to the secretion-theory.

New Sensory Organ in Lamellibranchiata.†—Dr. J. Thiele has examined the two yellow papillæ found near the anal papillæ in *Arca Noæ*. He finds that they are closely covered by long immobile hairs, and that in transverse sections their epithelium has a striking resemblance to that of the lateral organ of the abdomen, described by Eisig in the Capitellidæ. Internally there is a considerable layer of granules, among which is a network of processes, and thin spindles and rods. The author proposes to call these bodies abdominal sensory organs. They are supplied by a nerve which branches off from the most median of the nerves which extend backwards from the visceral ganglia; beneath the organ is a small ganglion, whence the separate nerve-fibres pass to the sensory cells.

Similar sensory spheres have been found not only in the closely allied *Pectunculus*, but in Aviculidæ, Pectinidæ, and Ostræidæ; they are distinguished fro mEisig's organs by their want of retractility, but this may be explained by their protected position in the mantle space. The author has not yet been able to find these organs in siphoniate Lamellibranchs, but the specimens examined were not very satisfactorily preserved.

Molluscoida.

α. Tunicata.

Observations on Ascidians.‡—Miss L. Sheldon commences with a note on the ciliated pit of Ascidians in its relation to the nerve-ganglion and so-called hypophysial gland. In the adult forms examined four main variations of the pit were observed; in *Clavellina* it is simple in shape, its opening into the mouth being round in section; it is situated ventrally to the nerve-ganglion into which it leads by a wide opening; in *Amarœcium* the pit is shorter and simpler, and has no connection with the ganglion; the mass of spongy tissue into which it opens appears to be degenerated, and somewhat resembles the notochordal tissue of vertebrate embryos. In *Ascidia* and *Ciona* the pit consists of a ciliated funnel passing into a canal; and in *Phallusia mammillata* there is a large reservoir lying ventrally to the ganglion which communicates with the mouth by a comparatively small orifice.

In the embryo of *Amarœcium* the nervous system consists of four portions; an anterior dorsal part which exactly resembles in structure the ganglion

* Zool. Anzeig., x. (1887) pp. 489–90. † Ibid., pp. 413–4.
‡ Quart. Journ. Micr. Sci., xxviii. (1887) pp. 131–48 (2 pls.).

of the adult, a mass which lies ventral and posterior to it, and is composed of very large ganglion-cells with very distinct nuclei and nerve-fibres; from the latter a nerve-cord passes off into the tail, and on one side of it there is a hollow sense-vesicle which has thin anterior and thick posterior walls; the unpaired eye is imbedded in the antero-dorsal angle of the wall, and the otolith is situated on its floor, and projects upwards into its cavity. This last is the only part of the nervous system which is hollow at this time. The ciliated pit opens into the solid nervous substance at about the middle point of the ventral surface of the first portion, and on the dorsal surface of the second.

As the ciliated pit of the embryo *Amarœcium* is connected exclusively with the brain, it seems probable that its original function was the aeration of the brain (compare the Nemertinea). In *Ascidia* and *Ciona*, and probably most other simple Ascidians, the function of the pit is that of a duct for the so-called hypophysial gland, while in *Clavellina* it communicates with the brain and probably aerates it, and also acts as a reservoir to carry off the secretion of the gland; or, in other words, has retained its primitive while taking on its secondary function. The pit is probably homologous with the hypophysis of vertebrates, in which the pineal gland possibly represents the dorsal continuation of the *ciliated pit*.

Some notes on the anatomy of *Cynthia* complete the paper.

Anatomy of Distaplia.*—M. F. Lahille describes the anatomy of the genus *Distaplia*, which has hitherto received but scant attention, though the form in question appears to be of some importance as a synthetic type.

There are 6 buccal, and 4 cloacal lobes, the latter forming a long tongue in the adult. Four rows of very long bars (trémas) are united medianly by transverse anastomosing vessels. The latter support the "inter-trematic" sinuses which much increase the respiratory surface. The transverse vessels, which in the high Phlebobranchs form what are called the ribs of second and third order, very rarely interrupt the bars in *Distaplia*. They are formed from the fusion of bifurcating papillæ which spring from the middle of each inter-trematic sinus. The transverse sinuses are in their disposition intermediate between that of the Diplosomiæ and that of the Aplidiæ.

The pericoronal groove (gouttière) is homologous with the vibratile arcs in *Appendicularias* and morphologically independent of the branchiæ in all Ascidians. Into it the vibratile oval organ opens, and two nerves occur on the base of the groove. The tentacles, at first two, then four in number, increase by the formation of four other pairs appearing on the neural side.

As in the Aplidiæ, the posterior portion of the branchia, to the side of the œsophagus, gives origin to the two endodermic tubes. These are, however, unequal and separate, do not involve heart or genital organs, and exhibit several muscle bundles and an ectodermic epithelium. They discharge the asexual multiplication, and correspond to stolon-tubes. Their marked development affects the other organs.

The intestinal gland is greatly developed, its ducts anastomose abundantly. It opens into a reservoir which communicates by a canal with the stomach. There is a cloacal diverticulum for incubation.

In all their characters the young forms are Diplosomidæ, and the Leptoclinidæ connect them with *Pyrosoma*. The adults are Distomidæ as regards the position of their viscera, but in general structure Aplidiæ.

* Bull. Soc. d'Hist. Nat. Toulouse, xxi. (1887) pp. 30-3.

Are the Tunicata degenerate Fishes? *—Prof. E. van Beneden discusses the arguments of Prof. A. Dohrn in favour of the degeneration of the Tunicate from fishes. He regards those arguments as based on the belief that the pseudobranchial grooves of the Cyclostomata are derived from a pair of branchial clefts, and that the rudiment of the thyroid of fishes, the hypobranchial organ of the Cyclostomata, the hypobranchial band of *Amphioxus*, and the endostyle of Tunicates, are the modified remains of another pair of branchial clefts. But the study of the innervation of the branchial apparatus of *Ammocœtes* shows that the first branchial cleft of the Cyclostomata is the homologue of the spiracle of Selachians, and the true branchial nerves of one have just the same disposition as those of the others. If its innervation is to be the criterion the thyroid body represents several segments.

In the answer which Prof. Dohrn has made to these criticisms he denies the statements of M. Julin as to the innervation of the branchial apparatus of *Ammocœtes*. Prof. van Beneden points out that the German naturalist has studied very small larvæ, whereas Julin examined such as had nearly completed their development. M. Julin is to investigate young forms in order to control the observations of Dohrn. In a further answer Dr. Dohrn refers merely to a slight criticism of Prof. Beneden.

Arthropoda.

Structure of Alimentary Canal.†—Prof. A. Schneider communicates a series of notes on the anatomy and histology of the alimentary canal of Arthropods.

(1) *The hypodermis* of insects consists, as Schneider and others have previously maintained, of a nucleated protoplasmic layer, without distinct cells, continuous with the sarcolemma and neurilemma of muscle and nerve, a literal ecto-mesoderm. Chitin is not an excreted substance, but a slow modification of the protoplasm. There is no real difference between that formed from muscle insertion, and that formed from the protoplasm.

(2) *Fore- and hind-gut* have the structure which one would expect in invaginations of the ectoderm,—internally a chitinous layer, not sharply defined from the outer homogeneous hypodermis, which is succeeded by a layer of transverse and longitudinal muscle-fibres, the sarcolemma of which is continuous with the hypodermis. The ridges of the hind-gut of caterpillars are formed from longitudinal muscle-fibres.

(3) *The mid-gut* exhibits (*a*) the cellular digestive and absorptive layer, (*b*) chitinous lamellæ, (*c*) hypodermis, and (*d*) muscle-fibres. The chitinous layer of this region is renewed like that of other parts during skin-casting. These results hold true of other Arthropods as well as insects, to which they principally refer.

(4) *Special structures.* (*a*) In many insects the hind-gut exhibits spinous modifications of the chitin. These are briefly referred to. (*b*) Similar chitinous thickenings in the fore-gut are much more frequent. Their disposition in various insects is simply noted.

(5) *Musculature of fore-gut.* The fibres are longitudinal and transverse, the latter occasionally radial. No notice has hitherto been taken of the occurrence of what may be called a "proboscis" (Rüssel). Posteriorly the fore-gut is in some cases evaginated forwards and outwards, projecting into the lumen of the mid-gut. This is associated with an alteration in the

* Zool. Anzeig., x. (1887) pp. 407–13, 433–6, and 582–3.
† Zool. Beitr. (Schneider), ii. (1887) pp. 82–96.

disposition of the muscle-fibres of the fore-gut. A second type of "proboscis" occurs in Hymenoptera, where a modification, originating as above, undergoes a second turning, the primary portion remaining undifferentiated and non-muscular.

(6) The memoir concludes with a description of the so-called funnel (Trichter), beginning at the end of the fore-gut. The first and commonest form arises on the outer surface of the proboscis, near its free end, in the form of a tube continuous with the chitinous layer, and extending on to the anus. A somewhat divergent modification occurs in ants, wasps, hornets, &c. In all cases it arises at first as a blind tube from the fore-gut. It appears to grow gradually by chitinous secretion at its anterior end, and to be dissolved posteriorly, passing out with the fæces. The common closed form protects the mid-gut from contact with hard substances. Its presence or absence, its closed or open form, depend on the nature of the food.

α. Insecta.

Spermatogenesis.*—Prof. v. la Valette St. George adds a fifth communication to his recent series of studies on spermatogenesis. He discusses the formation of the spermatocysts in Lepidoptera, and particularly the nature of the ensheathing membrane (Cystenhaut). What he long since stated, he still maintains, that the membrane arises from the apposition of individual cells. Recent observations have only confirmed his opinion. He also noticed the frequent occurrence of processes of various length and breadth arising from the membrane of the spermatocysts. The function of the "cystenhaut" is to inclose, separate, and bring to contemporaneous maturity its content of spermatocytes. Its *rôle* is fulfilled by other structures in other cases of spermatogenesis. The author notes the increasing adoption of his well-known nomenclature of spermatogenetic phases. The paper contains some lively criticism of recent investigations and investigators.

In concluding, Prof. v. la Valette St. George reiterates his classic law of spermatogenesis. The mother sperm-cells or *spermatogonia* (Stamsamenzellen, cellules de souche, &c., &c.), form by division an aggregate of cells—the spermatogemma—which in insects, as in Amphibia, acquires by the apposition of the peripheral cells a special sheath, and becomes a *spermatocyst* (Samenschlauch). The contents of this—the *spermatocytes* (Samenvermehrungszellen, cellules prolifératives, &c.), multiply by repeated division to form the immature sperms or *spermatides* (Samenausbildungszellen, &c.), from which finally the spermatozoa or *spermatosomata* result.

Tannin in Insects.†—Mr. Slater communicates the results of certain researches on the colours of insects. He considers that tannin, which is found in some leaf- and wood-eating species, may be the cause of certain of the yellow and yellowish-brown colours. Mr. Slater refers also to the experiments of M. Villou, who has extracted tannin from the corn-weevil. Black patterns Mr. Slater considers may be produced by the deposition of iron in the parts of the chitinous tissue, which readily takes up colouring matters when tannin is present. Similar lines and spots may be made to appear artificially by steeping the elytra in iron solution.

Histology of Enteric Canals of Insects.‡—Herr v. Faussek has discovered that in the mid-gut of *Eremobia* and the larva of *Æschna*, there are glandular crypts, formed by special cell-complexes, in addition to the

* Arch. f. Mikr. Anat., xxx. (1887) pp. 426–34 (1 pl.).
† Proc. Entomol. Soc. Lond., 1887, pp. 32–4.
‡ Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 694–712 (1 pl.).

cylindrical cells. In the cells of these glands, but not in those of the epithelium, mitotic division of the nucleus was observed. The rectum of *Eremobia* consists of two divisions which are separated from one another by a muscular valve; in both, the epithelial layer is well developed, and in that of the rectal glands there are mucous cells in addition to those of the ordinary cylindrical form. The rectum of the larva of *Æschna* also consists of two divisions, but these are not separated by any valve. Through its whole extent the epithelial cells are of two kinds, some being large with large nuclei, and the others small. The latter form compact folds, and the former either lie close to the muscular wall or give rise to simple folds widely separated from one another. In addition to its exterior gills, the rectum of these larvæ is provided with typical rectal glands.

Protective Value of Colour and Markings in Insects.* — Mr. E. B. Poulton has made a large series of experiments with the object of proving the protective value of colour and markings in insects in reference to their vertebrate enemies. He concludes that the extremely specialized defence of the larval stage follows from its delicate anatomical construction and the necessities which are imposed upon it as the great feeding stage. Highly conspicuous insects nearly always possess some unpleasant attribute, such as disagreeable taste or smell in the tissues and fluids of the body, irritating hairs, or stings, but in a small number of cases a conspicuous appearance has not yet been shown to be attended by any unpleasant attribute. In various species the same colours and patterns are again and again repeated, so that the vertebrate enemies are only compelled to learn a few types of appearance, and these types are of a kind which such enemies most easily learn. Certain appearances are especially impressed on them by highly aggressive insects, feared because of stings and so on; and hence, there is especial advantage in any approximation to such types. In a relatively few cases aggressive forms among the Vertebrata (serpents), are mimicked, though the insect itself is quite harmless.

Insects which are protectively coloured not uncommonly assume, when detected, a terrifying aspect, and in some cases take up offensive measures, such as the discharge of irritating fluid. A few forms, which are probably transitional, may be unconcealed, and yet not very conspicuous; these may possess unpleasant qualities, or may be eaten readily. As the likes and dislikes of insect-eaters are purely relative, and as, if pressed with hunger, they may eat the most disagreeable and highly conspicuous insects, we may here find an explanation of the fact that only a relatively small number of insects adopt such a means of defence. It seems probable that when one vertebrate eats an unpleasant insect and another refuses it, the former has conquered its prejudices, having originally disliked the insect.

In the sexually mature forms warning colours can be distinguished from sexual colours by their distribution on the surface of the body, by the way in which they are displayed in flight, by their type of pattern, and by the colours employed. The sexual colours or patterns are beautiful, the others conspicuous. This conspicuous appearance has relation to the injury which would be inflicted by the experimental "tasting" of certain enemies, such as birds or lizards; though enemies which, like frogs, inflict no injuries in tasting, have, to a limited extent, taken advantage of the warning colours.

Insects which evade their enemies by protective resemblance and attitude, by rapid movements or habits of concealment, are generally palatable, but they may possess an unpleasant taste or smell which may or may not protect them from their enemies; in a very small number of species the most perfect

* Proc. Zool. Soc. Lond., 1887, pp. 191–274.

form of protective resemblance may coexist with a most unpleasant taste. Mere size alone may protect a species against certain of its smaller foes. Comparing the different stages in Lepidoptera, unpleasant attributes appear to arise in the larval stage, and they then often pass through the two other stages attended or unattended, in one or both, by warning colours. The most highly specialized protective colours probably also possess value as sexual adornments.

Considerably more than one hundred species or stages of insects have been experimented on.

Lepidopterous Larvæ, &c.*—Mr. E. B. Poulton sums up the results of his observations during 1886 on Lepidopterous larvæ.

He shows that in the young conditions of *Smerinthus* and of *Sesia* there are characters present, many of which, though disappearing in later stages, serve to link together several of the allied genera.

Special reference is made to the red spots upon certain of the segments of *Smerinthus* which are considered as due to the modifications of a coloured border in ancestral forms. A new species of *Sphinx* larva from the Celebes with protective markings, as in *Chærocampa*, and with certain distinctly ancestral characters, is described. Interesting details are given as to the highly protective specialization which is met with among the Geometræ, in regard to their attitude and colour; and also as evident from the presence of certain otherwise useless processes on the body. Further mention is made of the defensive structures of the larva of *Dicrania* with their histological characters. Such defensive reversible glands must be considered as of fairly common occurrence, the *Liparidæ* affording many examples. Further facts are noted with reference to the life-history of *Paniscus cephalotes*. Suggestions are made as to the deposition of pigments in the superficial layer of the cuticle in many larvæ immediately before pupation, and upon the hereditary transmission of pink colour in the tubercles of *Saturnia carpini*.

Attention is called to the high protective specialization of the imago of *Gonoptera libatrix*, where the otherwise conspicuous eyes and antennæ are hidden when the insect is at rest.

The paper also contains remarks upon the advantage resulting from the late emergence of females from the pupa, and upon the greater readiness of larvæ in the younger than in older stages to feed on different plants. It is suggested that carnivorous habits are induced by a lack in the supply of the normal vegetable food.

Mr. Poulton and Dr. Dicey have both noticed the tendency of young larvæ to seek the light. Some kept in a glass cylinder congregated always where light was strongest. Larvæ also seem to appreciate the influence exerted by the force of gravitation.

Sound Organs of the Green Cicada.†—Dr. A. H. S. Lucas, after referring to the theory of Landois, mentions the recent defences of the older explanation of Réaumur offered by Prof. Lloyd Morgan and himself. He then states that the stridulating organ of the male *Cyclochila Australasiæ* is formed by a specialization of the tergum of the first abdominal and the sterna of the last thoracic and first abdominal segments. A pair of rattle membranes with chitinous ridges is borne dorsally, and these are moved, to produce the sound, by tendinous slips from the exaggerated abdominal muscles of the two segments involved. Ventrally, on each side, two delicate tense

* Trans. Entomol. Soc. Lond., 1887, pp. 281–321.

† Trans. and Proc. Roy. Soc. Victoria, xxiii. (1887) pp. 173–8.

membranes inclose three air-spaces which act as resonators, and are formed by the suppression of visceral and muscular elements. These essential organs are covered and protected by stout chitinous plates—a pair projecting forwards over the sclerous rattle membranes, and another pair arising externally to the legs in the mesothorax, and extending backwards to cover the air-chambers. The modifications are merely suggested in the female. A series of experiments is described which point clearly to the functions of the various organs as assigned to them by Mr. Lucas, and dissections and plates accompany the paper.

Structure of the Head of Blow-fly Larva.*—Prof. B. T. Lowne has come to the conclusion that embryology shows the futility of discussion with regard to the segmentation of the head in insects; he compares them with those which have been held with regard to the vertebrate skull; no segmentation occurs in the pre-oral region, and the head consists of an unsegmented pre-oral cap, developed from the cephalic fold, of two lateral procephalic lobes, and of three post-oral segments with their three pairs of lateral appendages. The antennæ are developed from the non-segmented pre-oral region, and, like the eyes, have no homologies with limbs. "A comparison between these structures and the post-oral appendages has no more basis in their developmental history than a comparison of the trabeculæ cranii with the ribs, or of the sense corpuscles of a vertebrate with its limbs." Mr. Lowne is of opinion that the whole exterior of the proboscis, except the labrum, represents the galeæ and stipes of the maxillæ, while the edges of the labrum and its apodemes represent the lacinia; if this view be correct there is nothing abnormal in the position of the maxillary palpi.

Sexual Generation of Chermes.†—Dr. F. Blochmann has elucidated an obscure point in the life-history of *Chermes* in discovering the sexual generation. The observations of Ratzeburg, Leuckart, and others had long since demonstrated (*a*) that a parthenogenetic, wingless generation passed the winter and deposited eggs at the base of the buds of the pine, (*b*) that their progeny developed in the galls and emerged in early summer as a parthenogenetic winged brood, and (*c*) that these produced a small yellowish wingless generation. It was supposed, direct evidence not being forthcoming, that the latter became the parthenogenetic winter generation (*a*) above referred to.

This Blochmann has shown to be a mistaken inference. The yellow coloured brood are *sexual*. Males and females are readily distinguishable, the former by the brown colour of the posterior portion of the body and by their very active habit. They possess two conspicuous testes and a penis beset with barbs. The females are yellow and not brown posteriorly, and of sluggish habit. They possess a single oviduct, two accessory glands, and a receptaculum seminis full of sperms. Both sexes exhibit a well-developed proboscis and alimentary canal.

After impregnation, the females hide at the bases of the needles on the somewhat thicker branches. There they lay a few eggs and die. From these fertilized ova the winter (*a*) parthenogenetic forms result. These are found at the bases of the buds from October onwards. The entire life-history thus closely resembles that of Phylloxera.

* Journ. Quek. Micr. Club, iii. (1887) pp. 120–4.
† Biol. Centralbl., vii. (1887) pp. 417–20.

β. Myriopoda.

New Species of Myriopoda.*—Mr. J. M'Neill gives descriptions of twelve new species of Myriopods, chiefly from Indiana. *Hexaglena* is the name applied to a new genus, in which there are six eyes, arranged in two divergent lines, close to the bases of the antennæ; the head is conical and minute, and there are spiracles in one row on each side of the body. The new genus differs from its nearest allies *Octoglena* and *Petaserpes*, in that the former of them has eight eyes, and the dorsal aspect of its head exposed, and the latter has only two eyes, while its spiracles are arranged in two rows. *H. cryptocephala* is a new species. The other new forms are *Polydesmus castaneus; Trichopetalum bollmani*, which is allied to *T. glomeratum; Lisiopetalum endasym; Iulus multiannulatus*, which is 165 mm. long, and is the largest species of the genus yet described from North America; *Geophilus brunneus, G. indianæ*, and *G. varians; Mecistocephalus strigosus*, and *M. foveatus;* and *Scolopocryptops nigridius*, which in general appearance and habits resembles *Lithobius*.

δ. Arachnida.

Phylogeny of Arachnida.†—In discussing the systems of organs in the Arachnida, Herr B. Weissenborn rightly commences with the nervous system, as questions of homologies between the appendages can only be answered by reference to the innervation. The nervous system of Arachnids is distinguished from that of most Arthropods by the absence of antennary nerves, but there are many points of agreement which show us that the system in all Arthropods exhibits a more or less well-marked segmental development and distribution; they all agree in having the parts derived from epiblastic thickenings, but in the Crustacea the rudiments are continuous, while in Arachnids and Myriopods, the rudiments of the central portion are distinct from those of the ventral medulla, and in insects they are only loosely connected. So far then the Arachnida agree with the Insecta and Myriopoda. With regard to histological structure and composition they all agree. The Tardigrada and the Pycnogonida present considerable variations from what is normal among the Arachnida.

The dermal skeleton of Arachnids, like that of other Arthropods, is a product of the integument, and differs considerably both in its qualitative and its quantitative development; the most various relations obtain with regard to external jointing. Here again the Tardigrada and the Pycnogonida are the most abnormal. In the former, and in the Acarina, the homonomy of the body segments, and the union of the anal and genital orifices are sharp marks of distinction, and coupled with other causes, seem to show that the Tardigrada are the offshoots of a branch of the articulate phylum, which separated off much earlier than that of the Arachnida, and perhaps even than the Arthropoda.

The appendages are next considered; the diminution in the number possessed by the Linguatulida and their small size may be explained by the cestode-like mode of life of these forms. Here, as in the dermal skeleton and the nervous system, the Scorpionida and Solpugida are groups which exhibit a primitive character in many of their characters, and they must therefore be regarded as standing near an older stem-group. The Pycnogonida are again aberrant, while the Tardigrada give just the same kind of evidence with their appendages as with their dermal skeleton.

The respiratory organs are not to be regarded as modified gills, but

* Proc. U.S. Nat. Museum, 1887, pp. 323–34 (1 pl.).

† Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 33–119.

merely as modifications of the respiratory organs which are found in *Peripatus*, the Myriopoda, and insects. There has been an adaptation to a lively mode of life, and, in correlation with the fusion of the segments and contraction of the hind body, a diminution in the number of stigmata. The great development of the skeleton of some has led to a marked localization of the respiratory apparatus of e. g. scorpions. The Solpugidæ present the most primitive relations of the thoracic stigmata, and the Scorpionidæ of the abdominal. While it may be supposed that the Tardigrada have lost their respiratory organs, the absence of them in the Pycnogonida must be referred to a primitive condition. Questions as to the homologies of the various stigmata can only be answered after an investigation into their developmental history; the original position of the openings may well be supposed to have been lateral and symmetrical. The diminution in the number of the stigmata has led to an increase of complexity in the tracheæ connected with those which are persistent.

ε. Crustacea.

Green Gland of Crayfish.*—Prof. C. Grobben replies to the memoir by Herr B. Rawitz † on the green gland of the crayfish. In that memoir almost all Grobben's previous results were declared by Rawitz to be erroneous. In replying to the criticism Professor Grobben reasserts his original conclusions, and as a comparison of the two reports will show, is in direct conflict with Rawitz on six important points.

(1) The canal of the green gland does not exhibit any division near its passage into the sac. The terminal sac of the gland passes into the green portion, and that into the white region which expands into the sac. (2) The yellowish-brown terminal portion of the green gland is distinctly a *sac* with folded walls. (3) Its colour does *not* depend on a yellow colour of the nuclei, but on yellowish-brown bodies in the protoplasm of the epithelial cells. (4) The cells of the green portion of the gland exhibit towards the lumen of the duct a thick cuticle (Stäbchencuticula). (5) The occurrence of strands in the protoplasm of the cells is to be seen in the white portion also, and in fact very distinctly. (6) The terminal sac is richly provided with blood-vessels.

Embryology of Mysis Chamæleo.‡—Herr J. Nusbaum commences his account of the embryology of *Mysis Chamæleo* with a description of the external changes undergone by the egg in the course of development. Perhaps the most interesting point is that which treats of the blastoderm; like E. van Beneden, the author finds that the blastoderm appears in the form of a disc, the edges of which grow around the entire egg; but Herr Nusbaum finds that this disc appears on what will be the ventral surface of the egg.

The egg is covered by a delicate homogeneous or transparent membrane; the contents are largely composed of the nutrient yolk, formed of more or less large spheres, round grains, and droplets of fat. At what will be the ventral pole of the egg, and just below the membrane, appears a disc formed by a finely granular protoplasm, having in its centre a rounded and slightly elongated nucleus; the plasma, which is granular at its centre, is converted at the side of the yolk into a homogeneous protoplasmic layer, which refracts the light strongly. Later on two nuclei are formed by the segmentation of the primitive nucleus. After a lacuna in

* Arch. f. Mikr. Anat., xxx. (1887) pp. 323–6. † See this Journal, *ante*, p. 748.
‡ Arch. Zool. Expér. et Gén., v. (1887) pp. 123–44 (2 pls.).

his observations the author observed a stage in which the formative protoplasm was differentiated into two layers, the outer of which was finely granular, while the inner was more coarsely so, and contained large highly refractive granules; the nuclei of both these layers appear to be the products of the segmentation nucleus. The division of the nucleus of the outer layer gives rise to a small blastodermic disc, formed of a single layer of hexagonal cells.

The mesoderm is originally paired, and is formed by the division of the ectodermal cells on the thickened borders of the ventral streak; it continues even to develop during the naupliiform stage, in which three pairs of rudimentary appendages have the form of small sacs, made up by a layer of hexagonal cells. Corresponding with the segments indicated by these appendages, the mesoderm undergoes a rudimentary segmentation. The body-cavity is formed in the anterior part of the body by the absorption of the yolk which is surrounded by the mesoderm; in the hinder part of the body the yolk is surrounded by endoderm, and the space between ectoderm and endoderm is filled by isolated mesodermic cells; these, later on, become connected with the ectoderm and endoderm, and between them the body-cavity appears.

The types of segmentation hitherto observed in the Crustacea are essentially four, three of which are holoblastic. In *Palæmon* Bobretzky has found it to be complete and regular; after the division of the nucleus the ovum divides into two segmentation spheres; the internal portions of all the cells fuse into a central vitelline mass, which is surrounded by a blastodermic layer. Mayer found in *Eupagurus Prideauxii* that the nucleus divided into two, four, eight parts; the independent cells thus developed migrate towards the surface of the egg, and there is then a total and regular segmentation of the egg. Here also the internal ends of the cells fuse into a single central vitelline mass. In *Calianassa mediterranea* and in *Asellus aquaticus* the nucleus and the surrounding protoplasm undergo segmentation in the interior of the egg, and after the formation of a certain number of cells these migrate, as in *Eupagurus;* the yolk then commences to undergo superficial segmentation in such a way that a vitelline segment is differentiated around each blastodermic cell, while the centre of the mass undergoes no segmentation; this type reminds us of what happens in insects. In the Schizopoda and in *Oniscus* a mesoblastic segmentation has been observed.

Brain of Mysis flexuosa.*—M. R. Koehler finds that the elements of the nerve-centre of *Mysis flexuosa* offer no special characters, but that the dotted substance is a good deal reduced. The greater part of the non-cellular portions are formed of packets of parallel fibres, which form very distinct bundles; the masses of granular dotted substance interposed among the fibrils are neither numerous nor extensive, and most are easily resolved, with a high magnifying power, into a close plexus of anastomosing fibrils. The topographical relations were studied by sections taken along varying planes, but the descriptions refer so closely to the illustrations that a general account is here impossible. The structure of the ventral chain is extremely simple, and the ganglia only project slightly beyond the connectives; in the abdomen the ganglia are even more reduced than in the other parts of the body; the connectives are formed of longitudinal fibres; those of the first three ganglia are separated by a certain quantity of connective tissue, but beyond it they approach one another, and are only separated by a delicate partition.

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 159–88 (2 pls.).

Shell of Hermit-crab.*—Mr. A. H. S. Lucas, commenting upon the usually accepted statement that hermit-crabs appropriate empty shells for protecting the defenceless part of the body, instances a case in which he observed the crab attack a living *Fasciolaria*, which it pulled out piecemeal after some time. From the appearance of the shells of tropical species of hermit-crabs Mr. Lucas is led to think that living rather than empty shells are usually seized.

Polar Globules in Isopoda.†—Herr G. Leichmann has observed the formation of two polar globules in *Asellus aquaticus*, and so has established an example of the ovum of a Malacostracan, richly provided with yolk, developing in the ordinary manner. As the presence of a nucleus in this stage has been denied by some writers the author desires to put its existence on record.

New Type of Compound Eye.‡—Mr. F. E. Beddard finds that in the retinula of *Serolis* there are only four cells. The rhabdom is not imbedded between them, but is only in contact at its upper part; the lower portion is surrounded by two large spherical transparent cells, which fit in closely between the four retinula-cells. The author has been able to find these hyaline cells in several species of Cymothoidæ. *Æga* has seven cells to each retinula, but the presence of the hyaline cells tends to confirm the view of many carcinologists as to the close relationship between the Serolidæ and the Cymothoidæ.

Pale variety of Asellus aquaticus.§ — Dr. R. Schneider gives the name of *Asellus aquaticus* var. *Fribergensis* to a pale variety of *A. aquaticus*, which has been found in the caves of Freiberg. The author considers that this new variety is of great interest as representing an intermediate stage between the two very closely allied species *A. aquaticus* and *A. cavaticus*. Another point of importance is the support afforded to the belief that forms which have become accommodated to subterranean life have a tendency to resort to young or embryonic conditions.

In *A. aquaticus* the pigment is well developed, and the general colour of the animal is, therefore, a deep brownish grey; its variety and *A. cavaticus* have no pigment, and are consequently milk-white in colour. The eye of *A. aquaticus* consists of four well-developed ocelli, almost imbedded in a continuous pigment-mass, and over each there is a closely connected and distinct cornea; in the variety the pigment-mass is by no means continuous, the cornea is indistinct and not closely connected with its ocellus; *A. cavaticus* has no eyes. The outer antennæ of *A. aquaticus* have about 60 joints, the variety 50–60, and these are more delicate and elongated; the other species has from 25–55. *A. aquaticus* and its variety have four coarse tactile setæ on the endopodite of the first pair of maxillæ, *A. cavaticus* has five, one of which is larger than the rest. The pedes spurii of the variety stand almost midway between those of the two species. The cuticular calcification of *A. aquaticus* is slight, and there are not many crystalline elements as there are in the variety, where, as in *A. cavaticus*, the calcification is well marked. In the characters of its long hepatic tubes the variety resembles the species with which it is associated. The excretory organ of the adult *A. aquaticus* forms a continuous tube on either side of the digestive heart, while in the variety these are more broken up,

* Trans. Roy. Soc. Victoria, xxii. (1886) pp. 61-3.
† Zool. Anzeig., x. pp. 533-4.
‡ Ann. and Mag. Nat. Hist., xx. (1887) pp. 233-6.
§ SB. K. Preuss. Akad. Wiss., 1887, pp. 723-42 (1 pl.).

just as they are in the young of *A. aquaticus*: those of the other species are not known.

Other juvenile characters which may be noted, are the reduction in the numbers of joints of the outer antennæ, and the presence, last of all, of pigment on the head, and especially near the eye.

Australian Cladocera.*—It is a well-known fact that the eggs of various fresh-water animals (notably those of Entomostraca) will withstand long desiccation, but still the experiments detailed by Prof. G. O. Sars have considerable interest. A correspondent sent him some dried mud from the shores of a fresh-water lake in tropical Australia. This mud was placed in water, and from it were hatched out one Copepod, one Ostracode, a species of Polyzoan, apparently belonging to the genus *Plumatella*, and five species of Cladocera. These last are made the subject of an exhaustive paper. The species all belonged to genera (*Daphnia*, *Diaphanosoma*, *Ceriodaphnia*, *Moina*, and *Leydigia*) already known from European waters, and the species of these genera themselves closely resemble those of the antipodes, notwithstanding that they came from localities thousands of miles apart, and which have entirely different environments. These facts recall to the author the close similarity, even identity, of the crustacean species of Italy and Norway, and he concludes that one cannot lay too great stress on the importance of birds in the distribution of these forms.

Vermes.

a. Annelida.

Anatomy of Earthworms.†—Mr. F. E. Beddard describes in *Eudrilus sylvicola* n. sp. an arrangement of the ovary and oviduct in which these parts occupy precisely the reverse positions to those figured by Prof. Perrier; in fact, the oviduct lies in front of and not behind the ovary. Attention is further drawn to the fact that the ovary and its duct are connected with one another, and that, therefore, there is not the difference between Annelids and Hirudinea which is ordinarily stated to obtain. The organs called testes by Prof. Perrier are really the vesiculæ seminales.‡ The terminal portion of the male generative apparatus of *Eudrilus* offers some points of interest; the glandular nature of the prostate gland is masked by the great development of its muscular layers, which give to it its characteristic nacreous appearance; the thick muscular coat is formed, for the greatest part, by longitudinal fibres; the glandular tissue is divided into two layers, which present an unmistakable resemblance to the epidermis of the clitellum; in its posterior half the prostate is divided into two independent tubes; one contains the continuation of the lumen of the prostate, and the other at first contains merely a mass of glandular cells; a lumen is soon developed. The vasa deferentia, after entering the prostate, become very fine tubes. Each portion of the prostate becomes continuous with a narrow tube that leads to the penis; this last is a muscular process of the walls of the bursa copulatrix, and contains a median canal which is continuous with the lumen of the duct of the prostate gland. In the possession of a muscular coat to the vas deferens *Eudrilus* presents another point of resemblance to the

* Forh. Vidensk. Selsk. Christiania, 1886, 49 pp. and 8 pls. Cf. Amer. Natural., xxi. (1887) p. 186.

† Proc. Zool. Soc. Lond., 1887, pp. 372–91 (1 pl.).

‡ It seems to be but little known that in his 'Forms of Animal Life,' the late Professor Rolleston correctly figured the position of the testes in the common earthworm, so that he comes between Hering (1857, *not* 1852) and the rediscovery by Professor Bourne.

leech. It will be necessary to form a new family for the reception of *Eudrilus.*

Mr. Beddard next makes some corrections, and gives some further information as to the reproductive organs of *Acanthodrilus*, and concludes with a note on the genital setæ of *Perichæta houlleti*, which have the general shape of imperfectly developed ordinary setæ, but terminate at their free end in a distinctly bifid extremity, the ends being connected by a delicate membrane.

New Species of Earthworm.*—Mr. F. E. Beddard describes *Cryptodrilus fletcheri*, a new species of earthworm from Queensland, which appears to be closely allied to *C. rusticus* Fletcher. The calciferous glands occupy an unusual position, for, instead of lying to the sides of the intestine, they are placed below it, and each gland comes into close relations with its fellow. The nephridia are on the type of *Microchæta* and some species of *Acanthodrilus;* they consist of a complicated coil of glandular tubules; their orifices alternate in position from segment to segment, but always correspond to one of the setæ. The seminal vesicles present the remarkable arrangement described by Mr. Fletcher, for a pair is placed in the ninth and another in the twelfth segment, the intermediate segments being without them, and, as in *C. rusticus*, the prostates are large. There are four pairs of spermathecæ, and these are interesting as presenting a difference in the minute structure of the spermatheca and its diverticulum, the latter having a very delicate epithelium, and the former tall columnar epithelial cells.

Anatomy of Hirudinea Rhynchobdellida.†—M. G. Dutilleul commences his notes on some points in the anatomy of the Rhynchobdellida with a discussion on the dorsal organ of *Glossiphonia*, which was first detected by Herr Nusbaum in *G. complanata*, where it is, however, provisional; it is also provisional in *G. marginata*, and the author believes that it is homologous with the permanent dorsal organ of *G. bioculata;* in this last it is nothing but a chitinous layer in a cutaneous depression, and M. Dutilleul thinks it would be well to call it the dorsal chitinous layer. With regard to the male apparatus of *G. sexoculata*, which it has been difficult to associate with that of allied species, on account of its abnormal form, the author states that he has discovered that the external branch of the U-shaped tube does not terminate in a free point, but is folded, directed backwards parallel to the axis of the body, and that it receives on its outer side the short deferent canals of the ten testicles of the corresponding side.

The wart-like tubercles of *Pontobdella* are found to be richly vascular and well provided with muscles, so that they represent differentiated respiratory organs, from which may be derived those of *Glossiphonia* and *Branchellion.*

Histology of Nervous System of Polychæta.‡—Dr. E. Rohde gives an account of his researches on the histology of the nervous system of the Aphroditeæ. His investigations mainly refer to *Aphrodite aculeata* Lin., *Hermione hystrix* Quatr., *Sigalion squamatum* Delle Ch., *Sthenelais dendrolepis* Clap., *Polynoe elegans* Gr. (*Lepidasthenia elegans* Mlmgr.), *Psammolyce arenosa* Delle Ch. He prefaces his memoir with an historical *résumé* of the relative researches of the last twenty-five years. He discusses in order (*a*) the ganglion-cells, (*b*) the central substance, (*c*) the nerves, (*d*) the relation of the ganglionic processes to (*b*) and (*c*), (*e*) the subcuticular fibrous tissue. His principal results are as follows:—

* Proc. Zool. Soc. Lond., 1887, pp. 544–8.
† Comptes Rendus, cv. (1887) pp. 128–30.
‡ Zool. Beitr. (Schneider), ii. (1887) pp. 1–87 (7 pls.).

(1) All the parts of the system consist of an internal nervous substance and an external sheath. (2) The latter (the subcuticular fibrous tissue) is a fibrous modification of the subcuticula. (3) The former consists of a cortex of ganglion-cells imbedded in the meshes of the subcuticular fibrous tissue, and of a central substance inclosed by the above and formed from ganglionic processes.

(4) The ganglion cells are all unipolar and membraneless. They are either (*a*) small, clear, pyriform, disposed in packets, and with numerous equal-sized nucleoli, or (*b*) large, darkly granular, round isolated cells, with one large refractive nucleus, or sometimes two differing in character. They are sometimes of enormous size. The two types are connected by transition forms. (5) The cell consists of two substances (*a*) a granular, fibrillar mitom, and (*b*) an apparently homogeneous intermediate substance, the paramitom.

(6) The central substance consists of fine, non-anastomosing fibrillæ, regularly disposed across one another in the brain, but longitudinal elsewhere. The central substance is but sparsely penetrated by processes of the subcuticular sheath. In the nerves the fibrils do not form fibres.

(7) The delicate processes of the first type of ganglion-cell pass directly, those of the others by brush-like terminations, into the fine fibrils of the central nervous substance. The length of the processes before they fall into fibrillæ is very variable, it depends partly on the size of the cell. Most of them break up in the same segment, while others are extremely long (giant fibres), extending along the entire system, and even following the nerves to the periphery. (8) The giant nerve-fibres consist of an axial cylinder (the process of the giant-cell), and a fibrous sheath. In those of the ventral nerve-cord, there is a wide space between sheath and axis; this is traversed by fine lateral fibrils penetrating the fibrous sheath, and possibly connecting the axial cylinder with the fibrils of the central substance. (10) Both the giant fibres and the central substance include very peculiar, small, round elements, like small multipolar ganglion-cells. They give off 3–4 fine fibrils, which, in the central substance, mix with the ordinary nerve-fibrils, and in the giant-fibres pass across the space like the fibrils above noted as arising from the axis-cylinder. This arrangement probably secures a second connection between the axis-cylinder of the giant-fibres and the central nervous substance. (11) The processes of the peripheral ganglion-cells stand in the same relation to the nerves, as the processes of the central ganglion-cells to the brain and nerve-cord.

Formation of Germinal Layers in Dasychone lucullana.*—M. L. Roule has endeavoured to settle the question as to the origin of the mesoblast in polychætous annelids, which has been differently answered by Dr. Hatschek and Prof. Salensky. He finds that the ova of *Dasychone*, which are richly supplied with yolk, segment very irregularly; of the first two segmentation-spheres, one is small and contains the greater part of the germinal material, and the other is larger and is formed of a compact mass of vitelline granulations. The former divides more rapidly than the latter, and its segments gradually surround the yolk until only one point is left uncovered. This corresponds to the blastopore of the larvæ of *Eupomatus* studied by Hatschek; at this stage a cavity appears in the region opposite to the blastopore. From the inner layer, at the time when the blastopore closes, some cells separate which will give rise to the mesoblast; in all the sections which the author examined, the number of initial mesoblast cells appeared to be more than two. The central mass of elements charged

* Comptes Rendus, cv. (1887) pp. 236–7.

with vitelline granulations corresponds therefore to a meso-endoblast, from which the future mesoblast cells are the first to be differentiated.

Organization of Chætopterus.*—M. J. Joyeux-Laffuie has examined *Chætopterus Valencinii.* He finds that the median hinder groove does not stop at the level of the first pair of appendages of the median region, or continue on to the second, as various authors have stated, but that it bifurcates and goes on as two deep grooves; their function is to conduct to the oral infundibulum the food-particles brought by the current of water which passes through the tube of the worm, and they are therefore analogous to the endostyle of Ascidians.

The nephridia are remarkably developed in *Chætopterus*, but they are not found in the most anterior division of the body. The infundibulum is semilunar, and the whole of its internal surface is covered uniformly with long vibratile cilia. At the level of each appendage the tube is enlarged to form a pouch, which is of considerable size, and opens to the exterior by a short canal. The cilia on the lining epithelium are very well developed. The tissue of the walls of the nephridium is formed of elements which resemble the cells of the organ of Bojanus; when separated they are spherical in form, and they contain a large nucleus which has one or more concretions in its interior; they sometimes increase in size and unite, when they form a calculus which almost completely fills the cell. Free calculi are often found in the excretory canal or in the pouch, and then the cells which give rise to them disappear.

The sexes are separate, but the male and female gonads have the same form and position; the products accumulate in large quantities, and give to the male a pale white, and to the female a slightly rosy colour.

Histology of Eunice.†—Prof. E. Jourdan describes the histology of two species of the genus *Eunice—E. Harassii* and *E. torquata.* The cuticle is remarkable for its thickness, and is seen by the use of reagents to consist of superposed lamellæ, which sometimes give it a regularly striated appearance; the existence of pores is best demonstrated after the use of such reagents—e. g. Hoffmann's green—as colour the contents of the underlying glandular cells. The epidermis is formed of cylindrical epithelial elements and glandular cells; the former are connected with one another by basal anastomosing branches, and give rise to the arrangement which Claparède distinguished as stellar connective tissue. The glandular cells are irregularly disposed on the body, being very rare on the dorsal surface, and most common at the edges of the ventral; some of these cells are hyaline and some are granular in appearance, but both are modifications of a single type of anatomical element. When the muscular fibres are teased, the irregularity and often the bizarre appearance of their forms are the first point to attract attention; they seem to be very long, are irregularly flattened, and indicate waves of contraction by thickenings scattered very irregularly along their whole extent. The author thinks that he has found evidence of true nerve-endings in the muscles, and states that he has observed similar arrangements in Holothurians.

In the account of the central nervous system we must content ourselves with noting a few points: the dotted substance is composed of very delicate, homogeneous fibrils quite like those which are met with in the peripheral nerves; they form so inextricable a plexus that the dotted substance cannot be separated out; the spaces of the close and delicate plexuses are occupied by an interfibrillar protoplasm which is sufficient to convert the

* Comptes Rendus, cv. (1887) pp. 125–7.
† Ann. Sci. Nat.—Zool., ii. (1887) pp. 239–304 (5 pls.).

central nucleus of the brain into a homogeneous mass. In the ventral cord we find, below the central mass of nerve-fibres, a hyaline structureless space, which corresponds to what other authors have called a giant nerve-fibre. M. Jourdan refuses to regard this structure as nervous, and looks upon it as being an organ of support for the ventral nervous system. Among the investments of the cord is a pigmented mass, which is specially accumulated above it. This mass is lodged in a plexus of cells with branched and anastomosing prolongations, and the cells themselves appear to be comparable to the plasmatic cells of the connective tissue of vertebrates.

After some account of the process of regeneration of the central nervous system, the author passes to the sensory organs, where the antennæ are first described; the eye has a crystalline lens provided with a capsule, formed by the folding over of a delicate portion of the body-wall; the body of the lens itself is semi-liquid, and is, possibly, analogous to the mucus secreted by the animal; the cells beyond it form the retina and vitreous body, and are nothing more than modified epithelial cells of the hypodermis; the author compares this simple eye with those of *Patella*, of Lamellibranchs, and with the simple eyes of Insects.

The digestive tract exhibits no indications of any glandular organ; the gills are essentially formed of two vessels covered by a layer of longitudinal muscles, and protected by an epithelium which is similar to that of the general surface of the body. The author thinks that there is no endothelial lining to the vessels of the Chætopoda; but as this would be a remarkable divergence from what obtains in other forms, he thinks it ought to be verified.

The observations on the "pedal glands," the lateral pigment-organs, and the segmental organs are collected into one chapter, as these parts have been long regarded as the same. The term of pedal gland is applied to the organ which Claparède regarded as pouring its secretion on to the setæ. Immediately beneath the setæ of each segment there is a mass of cells, which form a sort of epithelial bud on the internal surface of the integument. A superficial examination will suffice to show that these cells do not differ from the glandular elements which are found in the epidermis. They are so pressed against one another as to form a sort of multilobate racemose gland, the product of which passes to the exterior by a number of pores; these glands are better developed in *Eunice Harassii* than in *E. torquata*. The lateral pigment-organs were rightly regarded by Claparède, in opposition to Ehlers, as quite independent of the segmental organs; as to these last, which are very difficult to observe in most species of the genus, the great Swiss naturalist was unable to detect the external orifice. M. Jourdan comes to the conclusion that the organ opens to the exterior immediately below the pedal gland; the peripheral portion is formed of a membranous tube with flat cells on either surface, and appears to be rather an efferent vessel for the genital products than an organ of secretion.

Nervous System of Opheliaceæ.*—Dr. W. Kükenthal gives a detailed account of the structure of the nervous system in the Opheliaceæ.

Along the median line of the ventral surface there extend two parallel strands, which diverge and run to points at both ends, forking anteriorly so as to surround the gut. In two regions the strands are united, in the anterior portion of the head, and along the whole region from the anus to the third tail-segment. The two fibrous strands are surrounded by groups of ganglion-cells, and a common neurilemma ensheathes the entire system. Each segment contains two or three ganglionic aggregations. These give

* Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 511-80 (3 pls.).

off processes, in part to the nerves, in greater part to the longitudinal strand of the opposite side, and to a small extent to the longitudinal strand of the same side. The differentiation of ganglia and connecting commissures is not yet complete. Each complex of nerve-cells, the processes of which form part at least of each pair of nerves, is to be regarded as a ventral ganglion. There are four pairs of aggregates in each group, two lateral and two internal, two ventral, and two dorsal. As a portion of the processes of the lateral cells passes to the other side, two bridges are formed, one ventral and one dorsal. In each segment there are two or three such double bridges, and corresponding to these two or three pairs of nerves passing out from the same plane.

The strands surrounding the gut have the same structure. On their lower portion lies a ganglion, which in structure corresponds to half of a ganglion from the ventral cord. The same groups of cells are present except the median internal. Since the strongly developed sympathicus springs from this œsophageal commissure, the latter may be termed the stomatogastric centre.

The brain exhibits three pair of ganglia. Into both brain and ventral cord ectodermic elements enter. The upper surface of the brain exhibits a group of large round cells, possibly remnants of the apical plate of the larva.

The free-living forms (*Armandia*, *Polyophthalmus*) have a perfectly developed brain, while the ventral cord is still associated with the ectoderm; those creeping in the mud (especially *Travisia*) have the ventral nerve-cord completely separate from the ectoderm, but a reduced brain and sensory system. The memoir concludes with a comparison of Opheliaceæ and Archiannelids.

β. Nemathelminthes.

Anatomy of Gordiidæ.* — M. A. Villot is of opinion that Prof. Vejdovsky would have avoided some of the errors into which he has fallen with regard to the structure of the Gordiidæ, if he had made sections, had been able to examine the worms in the fresh state, and had a knowledge of their larval development. The French author has lately been so fortunate as to get examples of the parasitic stage of *G. violaceus*, which is passed in the abdominal cavity of *Procrustes coriaceus*.

The resemblance of the rings of the integument of embryos and larvæ to the segmentation of Annelids is apparent only, for they are merely due to folds of the integument. The fibrillar and nervous nature of the hypodermis is maintained, but M. Villot finds he was wrong in regarding the so-called nuclei as having any relations to the fibrillar elements; they are vascular organs which are connected with the pores of the epidermis and the aquiferous canals which traverse the dermis. To understand the origin and histological significance of the elements of which the integument is composed, it is necessary to study them in the parasitic larvæ before the formation of the dermis. Beneath the epidermic cuticle, there is a layer of embryonic cells, which, seen from above, is very like a pavement-epithelium; in each cell there is a large nucleus which stains well with carmine; on making a longitudinal section, it is seen that these embryonic cells have their protoplasm formed of developing fibrils, while their nucleus becomes vesicular and gives off at each pole a tubular prolongation; the ventral plexus and the central nervous system are only a special development of the fibrillar elements of the hypodermis, and the author was, therefore, wrong in previously ascribing to them a mesodermal origin.

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 189–212.

On a previous occasion M. Villot has insisted on the homology of the muscular fibres of Gordiidæ and Nematoids; he has since been able to detect a phase in the development of the muscular fibre of *Gordius* in which it is for a time in the stage in which those of Nematoids are permanently; the fibrillar substance only invests part of the inner wall of the embryonic cell, and the as yet unchanged portion is represented by a vesicular enlargement which is adherent to the parenchyma.

Some additions are made to our knowledge of the interesting phenomenon of the retrogression of the digestive tube, and it is found that what has been hitherto taken for the mouth of young *Gordii* is really an invaginated proboscis; it is the rostrum of the embryo which persists during the whole duration of the parasitic life, and only disappears in the adult when its cuticle is completely chitinized. The fibrous layer in the wall of the intestine is not muscular, but elastic in nature, and its development is more marked as the tube diminishes; in fact, it is these fibres which cause the contraction of the intestine.

There is really but one pair of ovaries, but each divides into two tubular branches, while the dorsal canal of Vejdovsky is a fifth unpaired and rudimentary branch; the receptaculum seminis is homologous with the ovaries; various points in which Vejdovsky appears to be in error with regard to the genital organs and the parenchyma are indicated.

The Gordiidæ are essentially characterized by their embryonic rostrum and the structure of their genital organs, as well as by the relative superiority of their integument, parenchyma, muscular and nervous system, and they should be distinguished from the Nematodes.

Development and Determination of free Gordii.*—M. A. Villot urges again attention to certain points in the life-history of *Gordius*, which appear to be still insufficiently recognized. They are: (1) these parasitic worms may leave their hosts at very different stages in development; (2) the chitinization of the cuticle causes, in adult individuals—whether free or parasitic—changes in coloration, form, and structure; (3) individuals of the same species may, even when completely developed, present very considerable differences in size. Having given evidence in support of these statements, the author proceeds to point out the importance of their bearing on the specific distinctions of various *Gordii*. We must be careful only to compare individuals of the same sex and age—in other words, forms of the same degree of chitinization, and we must be careful about the different phases of the chitinization of the cuticle in individuals of the same species. The forms lately described by Camerano—*G. Perronciti*, *G. Rosæ*, and *G. Piottii*, are all examples of the polymorphous *G. aquaticus* (or *G. subspiralis*). To be quite certain about the characters of a species of *Gordius* a large series of specimens must be compared.

Brown Cysts of Anguillula of the Beetroot.†—M. J. Chatin finds that under certain circumstances, and especially on the approach of winter, the females of *Heterodera Schachtii* undergo peculiar changes. The delicate integument gradually thickens, its glands furnishing an abundant secretion, which agglutinates organic and mineral substances, and so forms a sort of adventitious test around the female; this carapace closes up the buccal, anal, and vulvar orifices, and all connection between the worm and nourishing plant is broken. We have now a cyst filled with eggs, and comparable to an ootheca. It is easy to see how such a cyst can withstand the influences of bad weather. Later on, under more favourable conditions, the

* Zool. Anzeig., x. (1887) pp. 505–9. † Comptes Rendus, cv. (1887) pp. 130–2.

walls will swell and soften, and allow the eggs to escape. The importance of the knowledge of the life-history of this parasite will be obvious.

Anatomy of Echinorhynchi.*—The Acanthocephali have been regarded as devoid of a digestive apparatus, and Lespè's discovery of what he considered the elementary tract in the pyriform body in the proboscis of *Echinorhynchus claviceps* met with but little acceptance. Recently M. P. Mégnin has been studying the subject, and gave the result of his researches before the Scientific Congress of Paris.

In order to settle the question, it was necessary to study these worms at a period before the development of the sexual organs, and when the nutritive system was in full function. Mégnin found *Echinorhynchi* encysted in the cellular tissue of Varanidæ from the Sahara. These proved to be in a larval stage, and to have a digestive apparatus composed of two long convoluted tubes, each giving rise to numerous cæcal diverticula. The whole presents an analogy to the alimentary tract of the Trematodes. In some species, as the *E. brevicollis* found in *Balænoptera sibbaldi*, the digestive apparatus persists and acquires considerable development. In others it undergoes a degeneration, and is to be sought in the "lemnisci," structures, heretofore, of problematical nature, occasionally regarded as salivary glands. The larvæ have a rudimentary dorsal vessel, and this, with their proboscis and aquiferous apparatus (which, however, is well developed in the adult), shows the relation of the Acanthocephali to the Nemerteans or Rhynchocœla, while the digestive apparatus is more like that of the Trematodes. They can no longer be arranged with the Nematodes.

Development of Echinorhynchus gigas.†—Herr J. Kaiser has a preliminary report on the development of *Echinorhyncus gigas*. He finds that the ovaries, as soon as they are set free from the ligament, appear as elongate oval plasmatic discs, in which there are a number of granules of various sizes, and a considerable quantity of fat-like nuclei. The latter, with growth, either pass to the periphery of the ovary, increase in size at the cost of the rest, and form a simple layer of polyhedral cells, which invest the ovarial disc completely, or serve as nutrient material. As the cells of the epithelial investment grow, their colourless protoplasm becomes granular and turbid, and forms spherical structures, which move about freely in the cell-capsule. The spherical gives way to a spindle-shaped body, which bursts away from the ovary, and comes into contact with the spermatozoa. When impregnation is effected the egg becomes surrounded by a delicate clear membrane; the nucleus disappears, and the yolk begins to divide; segmentation is very irregular.

When there are about a dozen blastomeres a second embryonic envelope appears beneath the first; on the inner surface of the outer membrane a number of dark lenticular bodies become developed, and give rise to a shell, with which, in course of time, two other supporting membranes become connected.

During the development of these coverings the embryo has made further progress; there is an epibolic gastrula, and at one end the epiblast forms a considerable projection, in the centre of which there are six to eight nuclei; this syncytium is clearly the commencement of the nerve-centre. Later on a similar but less well developed cone appears at the aboral pole of the body. The embryo now obtains its covering of spines; between every four approximating epiblast cells there arises, as a secretion-product, a small thorn-like process.

* Amer. Natural., xxi. (1887) pp. 187–8. † Zool. Anzeig., x. (1887) pp. 414–9.

When the last sign of the central yolk disappears the embryo undergoes histolysis, the cell-walls disappearing, and the plasmatic bodies uniting; the nuclei are completely filled with highly refractive chromatin, and pass to the centre of the body, where they unite to form the so-called embryonic granular masses.

The syncytial plasma becomes differentiated into two layers; the inner one has in its centre the nuclear masses. In this condition the eggs pass out with the fæces of their host, and make their way into the intestine of the larva of *Cetonia aurata.*

The embryos, by the aid of their boring apparatus, bore through the chitinous lining of the lumen of the intestine, and through the glandular into the subjacent muscular layers. The free and exceedingly agile embryo has the form of a wide flask with a spherical base; besides the numerous small spines, which thickly cover the whole body, it has five large hooks, which are placed at the anterior end, and can be withdrawn into it. In their resting-place the embryos increase considerably in size; the first change which becomes apparent is that six nuclei become set free from the anterior end of the central nuclear mass; these become surrounded by a common plasmatic mass, which gradually assumes the form of an equilateral cone. On each of the six nuclei a small hook appears, in which it is not difficult to recognize the spinous process of the definite holding organ; when they have attained a certain size they pass forwards, and six fresh hooks appear; this process is repeated for from five to seven times. Almost simultaneously with the proboscis the rudiment of the body-covering of the definite worm is laid down in the form of a large-vesicled syncytium. In the anterior region the nuclei are laid down in two parallel zones. When the larva is from 4–5 mm. long the chief syncytium becomes converted into a simple layer of high cylindrical cells. The latter secrete a colourless mass, which later on hardens into the fibrous tissue of the subcuticula. But before this happens the first primitive muscle-fibres appear in the vertical walls of the cylindrical cells; these increase in number very rapidly; they break through the outer limiting membrane of the cells, and make their way into the still soft fibrous tissue of the subcuticula.

The endoderm gives rise to the body-musculature, the gonads, and the efferent genital ducts; the syncytial origin of the first of these is described.

γ. Platyhelminthes.

Developmental Cycle of Tænia nana.*—Prof. B. Grassi, in commencing his observations on the developmental history of *Tænia nana,* believed that the intermediate host of this human parasite was the mealworm. But all the experiments which he made were useless, as were also those made on animals, such as edible molluscs, lice, and so on, with which man comes into contact. The suggestion then recommended itself that, neither with this worm nor with *T. murina* was there an intermediate host at all. Trying this with young white mice, and carefully looking to their food after having fed them with *T. murina,* Prof. Grassi found that in fifteen days the *Tæniæ* had mature proglottids, and after about thirty days the eggs appeared in the fæces. Closer investigation showed that within fifty hours after feeding with proglottids the oncospheres of *T. murina* were found greatly increased in size in the terminal ten centimetres of the small intestine, where they were flask-shaped, and not unlike the bodies seen by Melnikow in *Trichodectes.* The embryonic hooks are ordinarily placed on the neck of the

* Centralbl. f. Bakteriol. u. Parasitenk., i. (1887) pp. 305–12.

flask; about the middle of the belly calcareous corpuscles were sometimes observed, and what appeared to be rudiments of suckers were seen on the neck. By the time that seventy hours have elapsed six embryonic hooks were observed on the neck; only a very narrow cavity, filled with fluid, lies between the scolex of the *Tænia* and the simple cyst which encloses it. There is no definite boundary between the scolex, the cyst, and the "neck"; and this last may be called the caudal appendage.

After these experiments with *T. murina*, which served to convince the author that he had here to do do with a direct development of a tapeworm without the assistance of an intermediate host, he and Calandruccio made experiments with the same *Tænia* on six human beings—four adults and two boys. A boy of five years of age, fifteen days after swallowing a number of proglottids of *T. murina*, had a certain quantity of ova of *T. nana* in his fæces, and, on being treated medicinally, passed fifty pieces of the latter tapeworm. Although these experiments are not conclusive, they lead to the supposition that this worm also ordinarily developes directly, and Prof. Grassi thinks that the same is true also of *T. elliptica;* at times they may develope indirectly, and, as the cysticerci of *T. mediocanellata* are very rare, it, too, may perhaps be another example of direct development.

Malformed Example of Tænia saginata.*—Prof. C. Grobben describes a specimen of *T. saginata* taken from a child six years old. Its form and coloration was such as to call to mind *Cerebratulus marginatus.* The portion examined was found to consist of a broad lower piece, and an upper somewhat narrower portion, separated by a constriction, and it measured in all 128 mm. There was no sign of jointing, so it was clear that the author had to do with a portion of a *Tænia* in which the formation of proglottids had not taken place; examples of this kind of arrest of development has already been put on record by Prof. Leuckart.

Sensory Organs of Turbellaria.†—Dr. L. Böhmig publishes a preliminary account of his investigations on the sensory organs of Turbellaria. In *Planaria gonocephala* the eyes have a long diameter of about 0·18 mm., while the other two dimensions are about 0·1 mm.; each eye has an investment of pigment formed of small blackish-brown spherules, and its convex side is surrounded by a delicate fringe of finely granular protoplasm, in which a number of distinct rounded nuclei can be made out. The presence of them would seem to show that the pigment-covering is derived from several cells, whereas in the eyes of Polyclads there is only one nucleus in the protoplasmic fringe. The so-called optic ganglion consists of a central ball of dotted substance, around which retinal cells are grouped. The optic nerve arises from a part of the brain where the dotted substance is distinguished by its greater fineness and more homogeneous appearance; this is the case also in some snails. The cells of the optic ganglion have a large nucleus, and though unipolar, each process soon divides into a number of smaller ones. The end-bulbs are not merely hyaline structureless bodies, but present a longitudinally striated thickening, which is separated by a thin hyaline plate from a finely granular terminal cap. As no lens could be detected, the author suggests that its function is performed by the parenchymatous tissue between the retina and the epithelium, which is viscous and transparent during life.

Among the rhabdocœlous Turbellaria, the Plagiostomida, which may have four eyes, have these organs more complicated than the Monotidæ.

* Verh. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 697–82.
† Zool. Anzeig., x. (1887) pp. 484–8.

A brief account is then given of the eyes of *Vorticeros auriculatum*, and *Enterostoma striatum;* in the latter the pigment-capsule contains two spherical structures, which, in well-preserved examples, exhibit a distinct longitudinal striation, due to the presence of extremely delicate bacilli, enclosed in a delicate intermediate substance. In these two forms lenticular cells are probably present.

In *Plagiostoma Girardi*, the contents of the pigment-capsule consists of two distinct substances; the larger hinder part of the cup is filled by a completely homogeneous substance which is only faintly stained by reagents; in front of it is a delicate band which is not coloured, but has no distinct horizontal striation. In front of the pigment-capsule is a group of cells, of which the central are larger than the peripheral. The structure regarded by Graff as the lens, consists of the contracted contents of the pigment-capsule which ought to be considered as the nerve-end apparatus.

The subcutaneous nerve-plexus, which, according to Lang and Ijima, is most apparent on the dorsal surface of Planarians, is to be seen in *P. gonocephala*, where it is best developed in the cephalic and auricular portions, and connected with it is an apparatus developed on the auriculæ, which may be regarded as an end-organ. On the dorsal surface of these processes there are small pits with a sharp and fine contour; at the base numerous nerve-fibres enter the pits from the subcutaneous plexus, and pass to a reniform body which fills the median third of the depression; this body is fibrous in structure, and from its free surface there project a number of thick round setæ, provided at their free ends with small capitula. The author suggests that the function of these organs is tactile.

Planaria Iheringii.*—Dr. L. Böhmig gives a general account of a new tricladid Planarian from Brazil. The worms are from 3·5–5 mm. long, 2–3 mm. broad, and 0·05 to 0·75 mm. thick. The ground-colour is bright yellowish-brown, or dirty whitish-yellow. At the edge of the head there are two whitish spots which project slightly beyond the margin of the body, and are the auricular processes. In the hinder third of the body are two orifices, one of which is the oral and the other the genital; the former leads to a pharynx, which, when completely protruded, is 1·4 mm. long; the latter to a narrow cleft which opens into a space largely occupied by the muscular penis; this space is the atrium genitale, and into it there open the vasa deferentia. The saccular uterus is of some size, and lies between the wall of the atrium and that of the pharyngeal space; its duct is provided with a highly developed musculature, and the two oviducts open separately into it. The paired germaria lie at about 0·8 mm. from the anterior pole of the body, while the vitellaria and testes lie in front of and behind the copulatory apparatus. The structure of the generative apparatus of this new species is of the type found in *Planaria polychroa*.

Graffilla Brauni.†—Herr F. Schmidt has discovered a fourth species of *Graffilla*, which he calls *G. Brauni;* it lives parasitically, and apparently abundantly, in *Teredo;* the largest specimens are from 2·5 to 3·2 mm. long, and about 1 mm. broad; the colour is generally whitish yellow. The protoplasm of the epithelial cells is, as in *G. muricicola*, finally striated; no rhabdites were observed; the dermomuscular tube is fully developed. The meshwork which forms the supporting substance of the body-parenchyma is extraordinarily fine, so that with low powers, the parenchyma has almost the appearance of a completely homogeneous mass. The new

* Zool. Anzeig., x. (1887) pp. 482–4.
† Arch. f. Naturgesch., lii. (1887) pp. 304–18 (2 pls.).

species agrees generally in the disposition of its venous system with *G. muricicola;* well-marked eyes are present. Like the just-mentioned species, *G. Brauni* has a kind of boring apparatus by means of which it is able to penetrate the body-wall of its host. The successive hermaphroditism of the genital products is not quite so well marked as in *G. muricicola* or *G. thetydicola*, for in moderately sized examples all the parts of the male apparatus are developed, while the female germ-glands were already ripe, and it was only in the largest individuals, where the ovaries were greatly developed, that the tubes were found to have completely disappeared. The female apparatus consists of germ-glands, vitellaria, atrium genitale with its appendix, receptaculum seminis, and shell-glands; the uterus communicates with the exterior by a very narrow genital canal. As in the two species already mentioned, the germaria have no membrane. In quite young individuals the ovary consists of a mass of finely granular protoplasm in which numerous nuclei are scattered; in the organs of older animals the protoplasm breaks up into the characteristic germinal discs.

G. Brauni appears to have an excretory system which differs a good deal from that of *G. muricicola.* Where a specimen is examined from the dorsal side, two large pyriform vesicles may be seen in the anterior fourth of the body; these open to the exterior by an extremely short fine canal between the epithelial cells. From each vesicle a ramifying canal extends backwards and forwards, but these could not be traced far, and they doubtless become very fine. The vesicles are invested by an extremely delicate membrane.

Dendrocœlum punctatum.*—Dr. W. Weltner gives a description of the large Planarian *Dendrocœlum punctatum* Pallas, which he found in the Tegelsee and also in the Spree near Berlin. He notes the external characters, the formation of cocoons, the number and appearance of the larvæ, but as his results are for the most part corroborations of the investigations of de Man and Hallez, the communication is almost exclusively of faunistic interest.

δ. Incertæ Sedis.

Dicyemidæ.†—Prof. M. Braun gives an account of what is known as to the curious parasites called *Dicyema*, first observed by Krohn in the "venous appendages" of the Cephalopoda, which will be useful for those who are unacquainted with the investigations that have been made on them. He concludes with a list of known species taken from Prof. Carus's 'Prodromus Faunæ Mediterraneæ.'

Anatomy and Systematic Position of Echinoderes.‡—Prof. W. Reinhard gives a detailed account of the anatomy of this enigmatic worm, and discusses the various suggestions that have been made as to its systematic position. He is himself inclined to associate it most closely with Annelids. With regard to its segmentation he is unable to accept the view of Hatschek that it is merely external and due to their mode of locomotion. The forward movements of *Echinoderes* are performed by the aid of the proboscis, and all other movements are very feeble. In his view, segmentation has not been independently acquired, but has been inherited; it is not only the outer covering that is segmented, but the whole body-wall corresponds, while in each segment there is a thickening separated by a constriction from its successor.

The most important peculiarity, in Prof. Reinhard's opinion, is the

* SB. K. Preuss. Akad. Wiss., 1887, pp. 795–804 (1 pl.).
† Centralbl. f. Bakteriol. u. Parasitenk., ii. (1887) pp. 386–90.
‡ Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 401–67 (3 pls.).

presence of setæ which traverse the carapace and are connected with the body-wall. These setæ completely correspond to the setæ of Annelids, and they form a transverse row in the midst of each segment in some species. Although, as a rule, Annelids are characterized by the presence of circular muscles, yet such are absent from *Polygordius*.

The external heteronomy of the segments in *Echinoderes* is almost as well marked as in Annelids. The excretory organs of the two groups undoubtedly correspond, and, as their number varies among Annelids, we need not wonder at their being reduced to a minimum in *Echinoderes*. The absence of an orifice from the anterior end of the segmental organ of the latter may be only apparent.

On the other hand, we must not omit to notice the important differences which undoubtedly exist between these two groups. These are the characteristic union of the plates of the carapaces between the separate segments, the absence of a distinct head, and the peculiarities of the musculature in *Echinoderes*; this form wants the parapodia, cirri, and gills so characteristic of Annelids, and cilia are found only in the excretory organs. Unless the muscles which extend from the back to the ventral surface are dissepiments, septa are wanting, and there is no ventral nerve-cord. No less important differences are presented by the reproductive organs, the absence of a circulatory system, the digestive organs, and the mode in which *Echinoderes* moves by the aid of its characteristic proboscis.

All these are sufficient to prevent the union of *Echinoderes* and Annelids in a single class, and for the former it is proposed to establish a special class, which, from the mode of locomotion, may be called the Kinorhyncha. The characters which the two groups possess in common may be explained by the supposition of the previous existence of a group of Proto-annelids (!), whose body was segmented, and had setæ and segmental organs of the primitive form, terminating as do those of Cestoda and Trematoda. All the suggestions here made must, however, be regarded as open to revision when the development of *Echinoderes* has been studied; of this at present nothing is known.

The species of the genus appear to live at the bottom of the sea in muddy and sandy places; near shore, where shells of Mollusca abounded, it was not found. In the neighbourhood of Odessa they do not live in any number at less than seven or eight fathoms depth, but in the open sea they were found in shallower waters. Eighteen species are already known, and the genus is very probably cosmopolitan.

Dinophilus gyrociliatus.*—Herr W. Repiakhoff has made a fresh study of the much discussed worm *Dinophilus*. (*a*) In regard to the species, the author maintains that the *D. apatris* so carefully described by Korschelt, and other species described by various authors, are identical with the original species discovered in 1848 by O. Schmidt, *D. gyrociliatus*. (*b*) His anatomical and embryological investigations corroborate those of Schmidt and Korschelt, and the new points elucidated are relatively unimportant. The author's attention was concentrated on the female form. (*c*) In regard to the much discussed question of the systematic position of *Dinophilus*, Repiakhoff canvasses the various opinions, and especially those represented by Lang and Korschelt, who refer it respectively to the Proto-annelids and to the Tubellarians. He sums up by defining its position as that of a "side branch from the Annelid stem, extricating itself from the Trochozoon type, and developing between the Rotatoria and the Proto-annelida."

* Mém. Soc. Néo-Russ. Nat. Odessa, x. (1886) p. 2. Cf. Arch. Slav. de Biol., iv. (1887) pp. 112–3.

Bipalium kewense.*—Though Mr. R. Trimen has found *Bipalium kewense* at the Cape of Good Hope, he is unable to give us any information of its exact habitat, for all the specimens seen by him have been found in cultivated grounds. He has observed multiplication by transverse fission, and the growth of the pieces. Abundant moisture is necessary to keep the worms alive.

New Rotifer.†—Mr. J. Hood describes a new species of the Rattulidæ, *Mastigocerca bicristata*, which he has found in marsh pools in Fifeshire and Perthshire. It is about 1/40 in. in total length, the long slender toe being nearly as long as the body. It feeds on *Confervæ*, desmids, and diatoms, and deposits its eggs among *Confervæ* or vegetable debris. The female only has been observed.

Balanoglossus Larva from the Bahamas.‡—In reference to his communication § on this subject, Mr. W. F. R. Weldon states that Prof. Spengel has convinced him that his series really belong to the normal order of development. He withdraws, therefore, his previous statement, and expresses regret for having published " an erroneous doctrine."

Echinodermata.

Development of Calcareous Plates of Amphiura.‖—Mr. J. W. Fewkes has studied the development of the well-known viviparous Ophiurid, *Amphiura squamata*. He finds that the intestine of the bisymmetrical larva is early developed, and later in development undergoes atrophy; the mouth, and possibly the œsophagus of this larva are formed by an epiblastic invagination during the time that the larva is still inclosed in its sac, and remains attached to the parent. The provisional skeleton of the bilateral larva is not always symmetrical, and sometimes developes on one side; the first formed rod is not always a trifid calcification; the first calcareous plates which form on the abactinal hemisome are the first five radials, and a little later, the dorso-central; the radials arise before the terminals. The first ambulacral are the plates which are first formed on the actinal hemisome; the second pair of adambulacral plates bear club-shaped spines, which are homologous with the spines of the lateral plates of the arms. The first-formed ventral plate belongs to the first pair of adambulacral plates, and not to the lateral arm-plates; though not belonging to the portion of the arm which is free from the disc, this ventral plate is homologous with the other ventral arm-plates.

The radial shields arise before the " underbasal " is formed between the dorso-central and the primary radials, and while there are but two intermediate plates in each of the interradii; the author discusses the homology of the plates which are looked upon by Carpenter as the basals, and doubts whether the particular ones selected by him are truly basals. The ambulacral plates do not always arise in the form of trifid spicules, for they sometimes appear as parallel unbranched rods.

The ova of a parasitic Crustacean (? Copepod) ¶ were often found, and the specimens which contained them were distinguished by having one or more of the interradial regions of a reddish colour, and more swollen than the rest. While the eggs of the Crustacean are bright red or pink, and arranged in packets, those of *Amphiura* are red and orange and are not in free packets. The adult form of this parasite is also found in *Amphiura*.

* Proc. Zool. Soc. Lond., 1887, pp. 548–50.
† Sci.-Gossip, 1887, p. 173 (2 figs.).
‡ Proc. Roy. Soc. Lond., xlii. (1887) p. 473.
§ See this Journal, *ante*, p. 597.
‖ Bull. Mus. Comp. Zool. Cambridge (U.S.A.), xiii. (1887) pp. 107–50 (3 pls.).
¶ Cf. this Journal, *ante*, p. 587.

Eocidaris.*—Dr. K. Kolesch has made a study of the characteristics of *Eocidaris keyserlingi*. In contrast to the true Cidaridæ it is pointed above; there are three different kinds of spines; individual variations were observed. It is not a Palechinid, but a Euechinid, for there are always two rows of interambulacral plates; mathematical computations show that there were twenty rows of plates, all the plates are pentagonal, and the lateral bounding line of the interambulacral areas is zigzag or notched.

New Holothurians.†—Prof. F. Jeffrey Bell gives descriptions of some new species of Holothurians from various localities. *Cucumaria sancti-johannis* is remarkable for the great reduction of the calcareous ring, the interradial pieces of which are fine filaments, and for the fact that the retractors of the pharynx are two-thirds the length of the whole body, and macroscopically, though not microscopically, seem to be tendinous for the greater part of their length. *Cuc. inconspicua* has the suckers almost, though not quite, regularly restricted to the ambulacral areæ, and so affords an argument against the distinction of the species of *Cucumaria* into two genera, according as the suckers are confined to the ambulacra, or scattered over the body. *Holothuria inermis* is remarkable not only from the want of spicules, but also by the absence of the calcareous œsophageal ring; *H. sæcularis* has none of the turriform spicules which are so generally present in the integument of the species of this genus.

Colochirus Lacazii.‡—M. E. Herouard describes a small Holothurian found near Roscoff at very low tide, which is interesting as being the first representative of this genus which has been found in European seas. It is white in colour and may reach a length of 70 to 80 centimetres. Its affinities with described forms are not pointed out.

Cœlenterata.

Regeneration of Polypes.§—Prof. M. Nussbaum reports that the continuation of his experiments confirms the experiences of Trembley. Arms of polyps cut off without any of the substance of the body attached always perish, but tentacles that retain ever so small a portion of the mouth-ring can form new polyps. This, he says, is owing to the absence in the tentacles of undifferentiated cells, which in the stomach portion replace the loss of the older and necessary tissues, and can be applied to the formation of the reproductive products.

Structure of Cunoctantha octonaria in adult and larval stages.‖—Mr. H. V. Wilson gives an account of this medusa, whose larval existence in the bell-cavity of *Turritopsis nutricola* has been described by M'Grady and by Brooks. The history of the form does not seem to confirm Prof. Häckel's idea that the difference between the Narcomedusæ and Trochomedusæ has been brought about by the migration of the tentacles from the umbrellar margin dorsalwards, for in *Cunoctantha* the four primary tentacles do not reach their ultimate position by a migration from the margin of the umbrella. Their final position is due to the outgrowth of intertentacular lobes, and to the growth of the velum, which fills up the interlobular notches, and then bends in to form the horizontal velum. The

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 639–65 (1 pl.).
† Proc. Zool. Soc. Lond., 1887, pp. 531–4 (1 pl.).
‡ Comptes Rendus, cv. (1887) pp. 234–6.
§ Verh. Naturh. Ver. Bonn, xliv. (1887) pp. 10–11.
‖ Studies Biol. Laborat. Johns-Hopkins Univ., iv. (1887) pp. 95–107 (3 pls.).

differences, however, are almost certainly of secondary origin, and due to the early development of the tentacles. It is impossible to place *Cunoctantha* in any one of Häckel's four families of the Narcomedusæ; the great German naturalist placed it with the Cunanthidæ, but, as it has no canal-system at all, it belongs rather to the Solmaridæ, from which, however, it is distinguished by the possession of otopupæ. In the shape of the true umbrellar edge it belongs to the Peganthidæ. The difficulties raised by this form, as by *Cunina proboscidea*, which Metschnikoff has shown to have otoporpæ and canals when produced from a fertilized egg, and no otoporpæ or canals when produced asexually, compel us to acknowledge that Häckel's classification is so far unsatisfactory.

Origin of Male Generative Cells of Eudendrium racemosum.*—Mr. C. Ishikawa has investigated *Eudendrium racemosum* with the object of seeing whether the theory of Prof. Weismann that all sexual cells in the Hydromedusæ were primitively of ectodermal origin is correct. He finds that, in the males, the young germinal cells which are found in the endoderm of quite young gonophores, attached to the supporting membrane, are really derived from the ectoderm. In some fortunate sections the author was able to find the young on the outer side of the supporting membrane, lying in the ectoderm; in later stages they had disappeared therefrom, and were only found in the endoderm.

A young blastostyle of *E. racemosum* already carrying a number of gonophores with ripe sperm-cells exhibits the following appearance in transverse sections: in sections taken through the base of the gonophores groups of small rounded primitive germ-cells were found partly lying directly on the supporting membrane, and partly deeper among the endodermal cells. Nearer the base of the blastostyle (but still in its capitulum) sections reveal the presence of these cell-groups not only in the endoderm, but also in the ectoderm, where they lie directly on the supporting membrane. They are exactly similar to the primitive germ-cells found in the endoderm, and the author thinks there can be no doubt that they are primary male germ-cells which have not yet made their way into the endoderm. Mr. Ishikawa is not, however, able to say whether all the male cells are differentiated in the blastostyl from the ectoderm, and whether some are not formed in the stalk of the hydranth, from which the blastostyl is developed.

Polyparium and Tubularia.†—Dr. A. Korotneff gives a full account of the remarkable *Polyparium ambulans*, the preliminary description of which we have already noticed.‡ The following is the author's opinion as to the systematic position of this peculiar form.

The chief characters are the absence of tentacles, the presence of various oral cones which lead into a common cavity, but have no œsophageal tube, the apparent absence of radial septa, and the presence of peculiar septa which divide the body into segments. When we make a comparative survey of other Cœlenterates we find that in *Mæandrina* separate polyps, or rather oval cones, like those of *Polyparium*, are arranged in band-like fashion on the surface of a spherical polyp-stock; the chief difference between them is that the cones are more numerous in the latter. In *Mæandrina* the tentacles do not surround every oral orifice, but are placed along the margin of each band. It must be supposed that in *Polyparium* also the tentacles migrated to the margin, and afterwards became lost; such

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 669–71. † Ibid., pp. 468–90 (1 pl.).
‡ See this Journal, 1886, p. 627.

a disappearance may be partially explained by a change in the mode of life, for the creature is able to move about, and has not, therefore, the same need for tentacles as has a fixed form.

The number of mouths may be supposed to be due to division, and the absence of an œsophagus to each supports this view. The change has had its influence on the internal organization, the septa especially having undergone a fundamental modification. If we suppose that a polyp were to lose its œsophageal tube the septa would project freely into the gastric cavity; if, further, the primary were to divide into a number of secondary mouths, and the colony were to be greatly elongated, the radial arrangement of the septa would disappear. The free mode of life has not been without its influence; to produce the definite movements the parieto-basilar muscle has become transverse, and the corresponding septa have become altered into partition-like structures. Thus the radial type of a polyp may be easily converted into the bilateral.

From the same island of Billiton Dr. Korotneff obtained a new species of *Tubularia*—*T. parasitica*—which he found living on a Gorgonian. The head of the polyp had the ordinary structure, and the genital products presented nothing remarkable. In endeavouring to settle how the two forms could become as intimately connected as they are, it is necessary to remember that a hollow Gorgonian is not rare, while a one-stemmed Tubularian is a really exceptional case. It must, therefore, be supposed that it is the Tubularian which has undergone an adaptive change which has suited its form to that of the Gorgonian—the latter then was the original host, and the former the parasite. It is possible that an embryo fixed itself either to the end or to the side of a branch of the Gorgonian, and then, if at the end, made its way in by boring, possibly with the aid of an acid, to the internal axial cavity, where it commenced to grow; in the neighbourhood the mantle of the host would be more feebly coloured, and much fewer polypides would be developed. If the embryo fixed itself to the side there would be no need for it to bore its way in, and the *Gorgonia* would in time grow over the Tubularian.

Polyparium ambulans.*—Prof. E. Ehlers has some suggestions as to the characters of Dr. Korotneff's form (see *supra*). He calls attention to *Ricordea florida*, in which from single persons there are developed colonies with incomplete division of the several persons. He differs from Korotneff in regarding *Polyparium* as one person, and he thinks that it has tentacles, but no mouth—the mouth-cones not being mouth-orifices, but tentacles; the observations of Prof. R. Hertwig on the Actiniaria of the 'Challenger' would support this view. If this be the right way of looking at the matter, the septa would be found to present no really abnormal characters. The most important question is raised when we come to discuss the phylogenetic origin of *Polyparium*, and the suggestion is made that it is a "paranomally" (as opposed to eunomally) developed animal, or one that, owing to the influence of external conditions, has departed from the typical mode of development, comparable to what is seen among fishes in the Leptocephalidæ. In fine, Prof. Ehlers is inclined to think that *Polyparium ambulans* is a mouthless single animal, derived from a unioral Actinian with wide degenerate tentacles, and that under the conditions of its life it has paranomally developed its band-like form; it may be able to reproduce itself asexually by fission. But Prof. Ehlers is careful to remark that his suggestions are made after reading Dr. Korotneff's paper only, and not after a personal examination of specimens.

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 491–8.

Morphology of Siphonophora.*—Prof. C. Chun commences by discussing the structure of the pneumatophore, which is shown by recent observations to be certainly a modified Medusa. He denies the accuracy of Korotneff's statement that it contains any gastric cavity. The pneumatophore consists, as is well known, of two lamellæ, an outer one which represents the continuation of the trunk, and an inner one which excretes the air—this inner layer may be called the air-sac, and the outer one the air-umbrella. Both consist of ectoderm and endoderm separated by a supporting lamella. As the air-chamber is an invagination of the apical end of the trunk, its inner surface is lined by ectoderm. In all the species there is a constriction at the lower pole of the air-sac which may be called the air-funnel. The lining ectodermal layer early forms a flattened epithelium, and even in the embryo gives off a delicate chitinous lamella, which forms a ring at the orifice of the sac; this lining is, moreover, multilaminate; the cells bounding the air-space are small and filled by a finely granular protoplasm; the underlying vacuolated cells gradually diminish in size, and are so packed as to be polyhedral in form.

There are a number of variations in the structure of the air-funnel which appear to be characteristic of different species; the structure is simplest in *Apolemia uvaria;* the endodermal investment of the funnel and the lowest part of the air-sac consists of long cells radially arranged in groups; the ectodermal cells, which are separated from them by a delicate supporting layer, form a thick multilaminate cushion. Part of this forms a secondary investment over the chitinous ring, and it was this that Korotneff mistook for a secondary stomach. In *Stephanomia picta* (= *Halistemma tergestinum* Claus) the pneumatophore is provided with internal septa, and these are swollen at their base owing to the entrance between the endodermal of large ectodermal cells, which form a solid mass.

In *Physalia hydrostatica*, the structure of whose pneumatophore has never yet been completely understood, the number of septa varies, but is ordinarily seven; the so-called septal canals represent branched solid "cellular tubes" which are formed of ectodermal cells, and which make their way from the air-funnel between both the septa and the finely granular ectodermal cells which grow into the lower fourth of the air-funnel. They are the homologues of similar cells in *Stephanomia.*

The remarkable structure of the pneumatophore of *Rhizophysa filiformis* is due to the loss of the septa, while the ectodermal cellular cords between them persist.

With regard to the physiology of the several parts of the pneumatophore, it is clear that it is the function of the ectodermal lining and of the secondary ectoderm to secrete air; the latter is larger in proportion to the size of the organ—in *Physalia*, for example, it forms a disc as broad as the hand, though, strangely enough, it has never yet been noted by any observer. The taking in of air from without is only possible in the Velellidæ and Porpitidæ, where there are a number of air-pores; they have no secondary ectoderm or air-funnel, and their camerate pneumatopore is completely invested by a thick chitinous layer. Though *Rhizophysa* and *Physalia* have an air-pore, it serves merely for the egress, and not for the entrance of air.

In investigating the morphology of this organ it is necessary to inquire whether the pneumatophore is a characteristic of the higher Siphonophora, or whether it has its homologue in a medusoid appendage of the Calycophoridæ? Chun has shown that the definite nectocalyces of the latter are

* Zool. Anzeig., x. (1887) pp. 511–5, 529–33.

probably preceded by a heteromorphous primary bell, and it is this which he regards as the homologue of the pneumatophore of the Physophoridæ. In other words: all Siphonophora have at the commencement of the trunk a heteromorphous medusoid appendage, which is after a time cast off by the Calycophoridæ, while it persists in other Siphonophora as a pneumatophore.

New Scyphomedusæ.*—Dr. W. Haacke gives an account of the Scyphomedusæ which he collected and studied from the Gulf of St. Vincent. (*a*) *Charybdea* (*Charybdusa*) *rastonii* n. sp. is especially interesting on account of the structure of its sensory organs which differ somewhat from the typical *Charybdea*. (*b*) *Cyanea muellerianthe* n. sp., a southern representative of this beautiful genus. (*c*) *Monorhiza hæckelii* n. g. et n. sp. forming along with Lendenfeld's genus *Pseudorhiza* the important family of Chaunostomidæ. Although both are certainly Rhizostomeæ with eight arms, it is peculiarly interesting that the Rhizostomatous condition is much restricted, so that they appear rather like Semostomeæ. In the genus described the Rhizostomatous condition was in the dozen specimens observed always restricted to one oral arm, which in contrast to the other seven exhibited a large, long and thick, three-cornered, terminal knob. This arm was always the left member of one of the four pairs. Young and adult specimens exhibited the same condition. The interest of this asymmetry is emphasized. Of three species, both young and adult forms are described at length. The memoir concludes with a faunistic chapter, in which the author discusses the geographical distribution. There are three coloured plates.

Anatomy of the Madreporaria.†—Dr. G. H. Fowler, in his third memoir on the anatomy of the Madreporaria, deals with *Turbinaria*, *Lophohelia*, *Seriatopora*, and *Pocillopora*. With regard to the first of these, the most important points that have been made out are that the polyps are of the normal actinian type, and are bilateral but not rigidly bisymmetrical; the septa, and, possibly, the tentacles are entocœlic only; the number of the septa is inconstant and bears no relation to any multiple of six; the general body-wall of the colony is supported upon the echinulations of the cœnenchyme, but this may be a secondary arrangement, which has been acquired for the purpose of support, contemporaneously with and in consequence of the development of cœnenchyme.

The polyps of *Lophohelia prolifera* are of the normal actinian type, save for the absence of directive mesenteries; this is, as yet, unique; its septa and tentacles are both ectocœlic and entocœlic, and, again, the number of septa are not necessarily a multiple of six; in the skeleton three series of centres of calcification are to be made out; of these, one lies in the theca itself; while the other two are at the summits of the ectocœlic and entocœlic septa respectively.

In *Seriatopora* the polyps are of the actinian type of structure; the septa are ecto- and entocœlic, and the body-wall is supported upon the echinulations of the cœnenchyme. The tentacles are remarkable for undergoing introversion, but no special musculature for effecting the contraction could be detected. Of the twelve mesenteries six are of some length, and six are rudimentary.

Pocillopora brevicornis closely resembles *Seriatopora subulata* in anatomical structure, but the tendency towards the exclusive assumption of

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 588–638 (3 pls.).
† Quart. Journ. Micr. Sci., xxviii. (1887) pp. 1–19 (2 pls.).

functions by six mesenteries is not so well marked; the polyps are monœcious.

In a concluding note, Dr. Fowler points out the logical fallacy of Dr. Koch's argument that the skeleton of *Flabellum* is an *epitheca*, and urges that there is nothing in the structure of its corallum which is really inconsistent with the idea that it is a theca.

Anatomy of Mussa and Euphyllia, and the Morphology of the Madreporarian Skeleton.*—Mr. G. C. Bourne gives an account of the anatomy of *Mussa* and *Euphyllia*, two genera of Madreporaria aporosa. In the former the soft tissues of the polyp extend downwards for a considerable distance on the outside of the corallum; so that there is a well-developed "Randplatte," and this contains extrathecal continuations of the exocœles and entocœles. The only point of divergence from the normal actinian type is the absence of directive mesenteries; this is the case also with *Euphyllia* and with *Lophohelia* (see Fowler, *supra*). The calicoblasts are either rounded or polygonal, or are drawn out into very long, narrow, columnar cells; the pyramidal or oval cells, which have been regarded by Sclater and v. Heider as calicoblasts, are always associated with the mesoglœa of the mesenteries, and are, as Fowler suggests, connected rather with the attachment of the mesentery to the corallum than with the secretion of coral. *Mussa*, *Euphelia*, and *Lophohelia* show no indication of bilateral symmetry, but are perfectly radial; this may be a primitive condition or may be connected with fissiparity. In *Euphyllia* the stomodœum is very long, and is converted into a ramifying and inosculating system of canals; the endoderm is greatly vacuolated, and becomes a reticulated tissue filling up the cœlenteron, in the meshes of which are numerous nematocysts and symbiotic algæ. In the stomodœal canals there are numerous fragments of vegetable matter; this observation is of interest, as it seems to be the first instance recorded of a coral feeding on a vegetable diet, and also as proving the digestive function of the enormously and peculiarly developed stomodœum.

The author suggests the following as the best provisional arrangement of the Madreporaria:—

I. M. with no directive mesenteries and a perfectly radial symmetry—*Lophohelia*, *Mussa*, and *Euphyllia*.
II. M. with directive mesenteries and a combined radial and bilateral symmetry—*Turbinaria*, *Rhodopsammia*, *Fungia*, &c.
III. M. with reduced radial symmetry and marked bilateral arrangement of parts—*Madrepora*, *Pocillopora*, *Seriatopora*.
IV. M. with a basal pseudotheca and no "Randplatte"—*Flabellum*.

The Madreporaria differ from the Alcyonaria in that the calcareous tissue is always external to the polyp; in the latter ectodermic cells become imbedded in the mesoglœa and there develope spicules.

Porifera.

Cladorhiza pentacrinus.†—Mr. A. Dendy describes a very remarkable Monaxonid sponge, which has a curious external resemblance to the pentacrinoid larva of *Antedon*. The sponge has a long slender stem, which terminates above in a subglobular body bearing a circlet of short pinnæ or

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 21–51 (2 pls.).
† Ann. and Mag. Nat. Hist., xx. (1887) pp. 279–82 (1 pl.).

arms; these curve upwards and inwards over the top. Below, the stem terminates in a number of very slender, long, branching rootlets. With the single exception of *Chondrocladia clavata* it is the smallest sponge known to the author, its total length being only 24 mm., of which the stem measures 11 mm. It was taken off the north-east of New Zealand, at a depth of 700 fathoms, and, like other deep-sea Monaxonids, it has a definite and symmetrical shape. The peculiar curvature of the pinnæ suggests that they may, during life, have the power of bending and unbending, but unfortunately the condition of the specimen did not admit of any investigation into the presence of those contractile fibre-cells, which Prof. Sollas has lately suggested should be called myocytes. Of the spicules, some of the microsclera are peculiar for the possession of three elongated, fang-like teeth at the small end of the spicule.

Protozoa.

√ **Theory of Sexuality.***—M. E. Maupas sums up in a theory of sexuality the results of his recent beautiful observations on the conjugation of ciliated infusorians. It will be remembered that according to Maupas the micronucleus is a hermaphrodite sexual element, of sole importance in conjugation. In the stage (A) it increases in size; it then divides twice (B and C), and eliminates the "corpuscles de rebut." This effected, it divides again (D), differentiating a male and female pronucleus. In the next stage (E) the male elements of the two conjugating Protozoa are exchanged, and the new male nucleus fuses with the original female portion. In the next two stages (F and G) the nuclear dualism characteristic of the Ciliata is re-established (the old macronucleus having broken up and been eliminated meanwhile). In the last stage (H) the ex-conjugates reassume their original organization before dividing for the first time.

What is the meaning of all this? There is no special sexual reproduction or generation. There is no acceleration of division after conjugation. It is a period of risk, especially during the inertia of reconstruction. It is a loss of time. An *Onychodromus grandis* had from 40,000 to 50,000 descendants while a pair were indulging in a single conjugation. It is a source of destruction, not of the multiplication of individuals.

The riddle was solved by a long series of careful observations. In November 1885 M. Maupas isolated a *Stylonychia pustulata*, and observed its generations till March 1886. By that time there had been 215 fissiparous generations. But at that time the colony gave in; the individuals had lost the powers of nutrition and reproduction. Individuals removed at various stages, however, had conjugated with members of different origin. The same experiment was repeated with other forms. In March 1886 an ex-conjugate from one of the couplings just referred to was removed and watched till the 10th July, when the family again gave in. During that time 315 divisions had been observed. Numerous conjugations had been effected with members removed to other families. This was done till the 130th generation, and till then all the conjugations were fertile. About the 180th generation individuals of the same family which had not hitherto been in contact with one another began in despair to conjugate. The results were, however, *nil*; the conjugates did not even recover from the effects of their forlorn hope. Other cases are related.

The result is evident. The process is essential for the *species*. The life runs in developmental cycles of multiplication by division, which are strictly limited. If conjugations with unrelated forms do not then occur

* Comptes Rendus, cv. (1887) pp. 356–9.

the life ebbs. The sexual conjugation of the Ciliates is thus a rejuvenescence, as Bütschli and Engelmann maintained. It is essential as a reorganization of the nucleus. After a prolonged series of divisions the nucleus undergoes senile degeneration. Without conjugation death would be inevitable. The death is a natural one, the occurrence of which some would deny. Sexual conjugation is the necessary condition of their "eternal youth and immortality."

New Infusoria.*—Prof. D. S. Kellicott describes four new species of Infusorians:—(1) *Podophrya inclinata*, spherical in young, pyriform in adult stages; sub-central spheroidal nucleus; rarely more than two small, slowly pulsating contractile vacuoles; few slightly capitate tentacles; curved pedicel, narrowed towards fixed base; on swimming feet of *Cambarus* from Magara river. (2) *Podophrya flexilis*, sub-spherical, plastic, with many granules in larger specimens; sub-central, ovoid, granular nucleus; single, anterior, slowly pulsating contractile vacuole; two to four, extensile, apparently capitate tentacles; short pedicel; on pedicels of *Epistylis digitalis* on *Cyclops*. (3) *Carchesium granulatum*, elongate, sub-cylindrical, slightly constricted below thickened peristome border; rows of cuticular elevations; moderately elevated, convex, tumid ciliated disc; long, twisted, longitudinal nucleus; two contractile vacuoles, slowly and alternately pulsating; pedicels dichotomously branched without septa; on *Cambarus* and plants. (4) *Opercularia humilis*, fusiform, transversely striated; U-shaped transverse nucleus; low contractile vacuole; peristome border thickened and slightly dilated; narrow, convex, moderately elevated lid; ample cilia; slightly elevated collar; very short pedicel; on *Gammarus* and Entomostraca; also notes on *Lagenophrys discoidea* and *Gerda sigmoides*.

New Fresh-water Infusoria.†—Dr. A. C. Stokes describes (1) *Anthophysa stagnatilis*, the colonies of which may consist of more than fifty zooids; its pedicle does not branch distinctly, the nucleus is placed in the posterior part of the body, and the contractile vesicle is near the centre of the same region. (2) *Hexamita gyrans* appears to carry the contractile vesicle along the course of its semifluid endoplasm; this vesicle appears to expand when near the posterior extremity, and to contract and disappear near the antero-lateral border. (3) *Chloromonas pulcherrima* has irregular and vacillating movements. (4) *Balanitizoon gyrans* executes movements by rapid revolutions on its longitudinal axis, with sudden lateral leaps; it is reproduced both by transverse and longitudinal fission. (5) *Gerda vernalis* was taken from beneath ice a quarter of an inch thick, but was quite lively. (6) *Rhabdostyla vernalis* has a shorter pedicle, and a more posteriorly placed contractile vesicle than *R. invaginata* Stokes; it is reproduced by longitudinal fission and by encystment; the former takes place rapidly, the body widening until the breadth is nearly equal to the length; it then divides into two longitudinal parts, the half which will finally develope an independent pedicle remaining attached to the original foot-stalk by the tip of its posterior extremity until it has produced a ciliary girdle, by means of which it swims about freely for a short time. In encystment the animalcules remain quiescent and unchanged for an indefinite and unknown time. (7) *R. chæticola* was found attached to the dorso-lateral setæ of *Nais*. (8) *Vorticella similis* has considerable resemblance to *V. pattelina* Müll., but differs, not only in its fresh-water habitat, but by its striated surfaces, revolute edge to the peristome, and much smaller size. (9) *V. vernalis* belongs to the group in which the surface is ornamented by cuticular monilations, but is distin-

* Microscope, vii. (1887) pp. 226–33 (4 figs.).
† Amer. Mon. Micr. Journ., viii. (1887) pp. 141–7.

guished from all known forms by the combination of rounded prominences and transverse striations. (10) *V. parasita* was found attached to the body of an aquatic worm. (11) *V. conica* has a much elongated body, and when contracted exhibits posterior annulations. It appears to be much less timid than most *Vorticellæ*, for the cover-glass may be repeatedly and somewhat violently disturbed without in any way altering the expanded animal; this may be explained as due to the activity of the supporting host, for the *Cyclops* leaps through the water with rapid and often long-continued movements. (12) *Epistylis tincta* resembles *E. flavicans* somewhat closely in some of its characters, but differs in having the contracted zooids pyriform and not subspherical in shape, and the ultimate divisions of the pedicle more than twice as long as the expanded bodies. In the hinder part of the bodies of most representatives of this new species there was a cluster of refractive and apparently crystalline bodies, the nature of which is quite problematical; they often occur in young colonies composed of only two zooids, and are absent from older zoodendria formed of many. (13) The last new form is *Lagenophrys obovata*, which in form and size most nearly resembles *L. vaginicola*, but differs from it in the less cordate aspect of the lorica, and the narrower anterior region. A woodcut is given illustrating these forms.

New Hypotrichous Infusoria from American Fresh Waters.* — Dr. A. C. Stokes describes as a new genus *Onychodromopsis*, which differs from *Onychodromus* chiefly on account of the soft, flexible, and uncuirassed condition of the body. On the dorsal surface there are numerous short, hispid setæ; *O. flexilis* is the new species. *Tachysoma agile* is the type of a new genus which is distinguished from *Pleurotricha* by the absence of the supplementary ventral series of styles, and the softness and flexibility of the body; these latter characters, with the absence of caudal setæ, distinguish it from *Stylonychia*, which it otherwise somewhat closely resembles; as it has the marginal setæ of the posterior border interrupted it cannot be placed with *Oxytricha*; its systematic position is probably between the last-named genus and *Histrio*; *T. mirabile*, and *T. parvistylum*, are the other new species of the genus. The other new species described in the paper are *Litonotus vermicularis*, which may be 1/60 to 1/30 in. long, and the largest and mature forms are visible to the naked eye as fine white threads gliding through the water; *Loxodes magnus*, which is 1/40 in. long; *Oxytricha bifaria*, *O. hymenostoma*, *O. acuminata*, and *O. caudata*; *Histrio inquietus* and *complanatus*; *Euplotes variabilis*; and *Chilodon vorax*, as to which we have the following very interesting account:—

"The infusorians under observation fed voraciously on certain linear diatoms (probably a species of *Nitzschia*), with which the water teemed, the frustules often being considerably longer than the body of the animalcule in its normal condition, and after being engulfed, consequently, extending through the entire length of the infusorian, and stretching the cuticular surface at both extremities until at these points the limiting membrane became the merest film. Before the process of engulfing was actually witnessed, it was an interesting problem as to how the diatom became freed from the posterior region of the pharyngeal passage which extends almost to the centre of the body. . . . During the passage of the frustule, when the cuticular surface of the rear margin of the body has reached its limit of extension, the pharyngeal tube, containing one end of the long diatom, suddenly and violently rotates forward until its normal position is completely reversed, and the diatom consequently slips out. The act is probably only to a certain extent voluntary, being effectually

* Ann. and Mag. Nat. Hist., xx. (1887) pp. 104–14 (1 pl.).

aided by the strong pressure from the extended cuticular surface, which tends to force the pharyngeal fascicle forward."

Development of fresh-water Peridineæ.*—M. J. Danysz comes to the conclusion that there is great uniformity in the developmental history of widely separated genera of Peridineæ, and is of opinion that these forms should be associated rather with plants than animals.

The following seem to be the successive stages:—Active individuals multiply by successive fissions, and become smaller and smaller. Notwithstanding the great differences in the structure of the body and of the nucleus, the process of division is identical in all; it is always effected along the longitudinal axis of the body, the line of separation being a little oblique to the transverse axis. Phases of multiplication similar to those seen in active forms are to be observed in individuals, which, owing to the liquid which contains them being less fluid than pure water, are in a state of repose. The author thinks that the cause of this phenomenon is purely mechanical. The conditions which M. Danysz looks upon as those of fission were regarded by Stein as states of conjugation. The period of multiplication is followed by that of spore-formation, which has been followed in *Gymnodium musci* D. and *G. glaciale* sp. n.

The spores are spherical bodies quite unlike their mother-cells; the protoplasm is covered by two membranes, the outer of which is thick, and formed of two layers of different chemical properties, while the inner is delicate and hyaline; the protoplasm, which is finely granular, contains a large number of various kinds of corpuscles; these are very small chromoleucytes which are scattered through the bodies of active individuals and localized into one or several corpuscles in the cysts; when these are differently coloured, those of distinct colours separate from each other. Drops of oil and of fatty bodies in the solid state, which are probably due to the transformation of starch or granulose, are either found scattered irregularly, or arranged in order in the protoplasm of the spore. The inner lamella of the outer range appear to be pure cellulose, while the outer lamella is probably chitinized cellulose. The inner hyaline layer appears to be the membranous layer of the protoplasm.

Reproduction of Euglypha.†—Dr. F. Blochmann describes experiments which supplement Gruber's observations on the division process amongst shell-bearing fresh-water Rhizopoda, which showed that these forms multiply by a budding process. The bud is covered with shell plates as it is formed, and a division of the nucleus occurs at the same time. Separation usually occurs when the bud has reached the size of the parent; but Dr. Blochmann observes that, in very many cases, further changes before separation end in the death of the budded off portion, so the process results in no multiplication of individuals. A drawing back of the protoplasm into the original shell leaves the new one empty of all but the young nucleus, which had been pushed into it. This nucleus remains attached to the base of the new shell, and evidently dies as soon as the protoplasm becomes separated from it. Now either of two things may happen. The shell and dead nucleus may fall off together; or the dead nucleus may again be drawn into the original shell—a pseudopodium flowing round it, and holding it for a time, but ultimately again extruding it. No change in the individual was noted after this curious phenomenon, which Dr. Blochmann compares to the extrusion of polar bodies from the eggs of Metazoa. He thinks a similar process was mistaken by Jickeli for

* Comptes Rendus, cv. (1887) pp. 238–40.
† Morphol. Jahrb., xiii. (1887) pp. 173–83 (1 pl.).

conjugation in *Difflugia globulosa*. He further describes cases of actual conjugation in *Euglypha*, and enumerates the points by which these can be distinguished from cases of division. The individuals, after conjugation, either divided or encysted in the manner which Gruber describes; but, in one instance, two conjugated *Euglyphæ* formed one large one, which included the protoplasm and fused nuclei of both elements, and which finally encysted.

Planispirina.*—M. C. Schlumberger describes the three most important species of the genus *Planispirina*, whose dimorphism has not yet been noticed: they are, *P. sigmoidea* Brady, *P. celata* Costa, and *P. edwardsi* n. sp. He next proceeds to discuss the opinion of Mr. H. B. Brady as to the generic distinctiveness of these and some allied forms, and, contrary to the judgment of that naturalist, comes to the conclusion that the mode of disposition of the chambers of their tests is sufficiently characteristic to justify the creation of a new genus, for which M. Schlumberger proposes the name of *Sigmoïlina*.

New Parasitic Rhizopod.†—M. A. Giard finds that at Concarneau, and especially at Fécamp, the *Cancerilla*, which is parasitic on *Amphiura squamata*,‡ has on its own carapace a fine parasitic Rhizopod. This, which may be called *Podarcella Cancerillæ* g. et sp. n., is a pedunculated Arcellid. The peduncle adheres to the cephalothorax of the host by a small discoidal expansion; it is once and a half as long as the funnel-shaped cupule which terminates it, and, like it, it is formed of a substance which is apparently chitinous. The amœboid body moves slowly in this cupule.

Amœbæ of Variola vera.§—Dr. A. van der Loeff placed some pock matter taken from two persons suffering from confluent small-pox in sterilized tubes, and examined it on the evening of the same day in hanging drops. The same corpuscles—Proteidæ or *Amœbæ*—were found in large numbers and of various configuration, as were found by the author in fresh animal lymph. Even in cover-glass preparations the *Amœbæ* could be easily recognized after staining with fuchsin.

Protozoa of the Black Sea.‖—Miss B. Peréraslavtzéva has endeavoured to make the list of Black Sea Protozoa more approximately complete. The memoir includes a list of 100 species. Of these 18 are new, and are described and carefully figured. The author has also sought to test the accuracy of the generalizations formulated by Merejkowski in regard to the geographical distribution of the Protozoa, and has been forced to refute them.

Parasites in the Blood.¶—Prof. B. Danilewsky concludes his study of the hematozoic parasites of the tortoise. In investigating the different organs, he found but little of importance in the spleen or kidney, except that in the latter he detected the presence of the Gregarinoid spores in the pseudonavicella stage. The study of the medulla in the bone-cavities yielded valuable results, especially in young tortoises. In this tissue the hæmo-Gregarinid parasites are extremely abundant in all stages of development—young, adult, and free. The various forms are described in detail. The investigation of the marrow was the more important since Bizzozero and Torre have maintained that this tissue is in the tortoise the sole seat of the manufacture of red blood-corpuscles. In the hæmatoblasts, as was to

* Bull. Soc. Zool. France, xii. (1887) pp. 475–88 (1 pl.).

† Comptes Rendus, civ. (1887) p. 1191.

‡ See this Journal, *ante*, p. 587.

§ Monatshefte f. prakt. Dermatol., 1887.

‖ Mém. Soc. Néo-Russ. Natural. Odessa, x. (1886) p. 2 (3 pls.). Cf. Arch. Slav. de Biol., iv. (1887) p. 116.

¶ Arch. Slav. de Biol., iii. (1887) pp. 370–417.

be expected, abundant hæmatozoic embryos were found. In the same region Prof. Danilewsky also observed within the corpuscles oval masses, which divided by a process of (muriform) segmentation (hardly to be described as sporulation) into a number of embryos. In other cases the minute embryos were seen apart, evidently liberated from a ruptured cytocyst.

According to the author, each corpuscle containing a hæmogregarine parasite, has received the latter from a hæmatoblast. The hæmatoblast may itself have engulfed a germ, or may have received it from a leucocyte.

Germs originating from a spore-forming Gregarine in some part of the alimentary canal or urino-genital ducts may readily become included in the leucocytes. In the interior of the latter the germ undergoes a solitary and progressive development, while the containing cell is transformed into a blood-corpuscle. In this intracellular life the parasite passes through the stages which in the normal history of Gregarines are known as primitive germ, pseudonavicella, falciform body, and mobile adult. In contrast to the usual history the hæmogregarine developes within the corpuscle from an almost imperceptible germ to maximum size, and that at the expense of extrinsic nutritive material. There is a certain parallelism, not without exceptions however, between the blood-corpuscle and the included hæmogregarine. The presence of the parasite does not appear to affect the vitality of the developing blood-corpuscle.

As to the mode of introduction into the tortoise, Prof. Danilewsky is inclined to regard the alimentary canal as the most probable entrance, and there is no doubt that in the insects, myriopods, &c., eaten as food, there is an abundant source of supply for Gregarinoid parasites.

New Parasite of the Pock-process belonging to the Sporozoa.*— Dr. L. Pfeiffer has found a coccidia-like parasite which, in company with fungi and bacteria, lives in the pocks of various mammals and of man, and passes its first stages in the epithelial cells of the rete Malpighii: in this respect it would agree with the coccidia inhabiting epithelia (e. g. *Coccidium oviforme* Leuck.). The author found it very frequently in sections through the rete, partly in layers, partly within the epithelial cells, which were swollen up by the growth of the spherical parasites and finally destroyed. The smallest examples are 0·009 mm. large, and show a bright nuclear-like spot about 0·005 mm. in size. Like *Coccidia*, this *Monocystis epithelialis*, as the author calls it, forms a thick sheath, the original capsule is thrown off and a new one formed. Several examples are rarely found in one cyst. After incapsulation sporulation begins. The spores which are found in quantity in the lymph appear to pass directly into amœboid, slightly mobile embryonic bodies. The author regards the transparent blood-corpuscle-like discs as the young condition of the parasite, and is disposed to think that the entrance into the epithelial cells is perhaps not necessary for its development, as the parasites are found free in the protoplasm of the vesicles, and as it is possible to breed and propagate them in the artificial media up to the third generation.

* Correspondenz-Blätter allg. ärztl. Vereins v. Thüringen, 1887, No. 2, 12 pp. (2 pls.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.*

(1) Cell-structure and Protoplasm.

Morphological and Chemical Composition of Protoplasm.†—In this very exhaustive treatise Herr F. Schwarz enters into great detail with respect to the behaviour of the different constituents of the protoplasm of the vegetable cell with various reagents; only the more important results can be indicated here.

The varying acid or alkaline reaction of the cell-sap in different cases he attributes to the pigments or other substances contained in solution in it; in no case has he found the protoplasm to have an acid, but in most cases a distinctly alkaline reaction; and this applies equally to the cytoplasm, the nucleus, the chromatophores, and the microsomes, and in some cases also to the protein-grains. This alkaline reaction is not due to the presence in the protoplasm of ammonia or other free alkalies, but probably to alkaline salts, especially phosphates, combined with the albuminoids in the living cell.

The author regards the chlorophyll-bodies as having a fibrillar structure; the fibrillæ do not, however, form a network, but lie side by side, filling up the entire mass of the chlorophyll-body. The fibrillæ, composed of a substance which he calls *chloroplastin*, are not uniform in colour, but contain globular bodies of a deeper green than the rest, the vacuoles or "grana" of Meyer; between the fibrillæ is a colourless substance, the *metaxin*. These two components of the chlorophyll-bodies can be separated by the action of water, in which the fibrillæ swell up strongly, but are entirely insoluble, while the metaxin is finally completely dissolved. They may also be distinguished by other chemical reactions.

As components of the nucleus, Schwartz distinguishes the following substances:—(1) *chromatin*, the portion most sensitive to staining, occurring in the form of larger or smaller globules or granules, the "nucleo-microsomes" of Strasburger; (2) *pyrenin* and *amphipyrenin*, which constitute, respectively, the body and the membrane of the nucleus; these differ widely in their reactions from chromatin, and from one another, the former taking up staining reagents much more readily; (3) *linin* and *paralinin*, the substance respectively of the nuclear threads, the "nucleo-hyaloplasm" of Strasburger, and of the intermediate matrix or "nuclear sap." The behaviour of these various substances towards different reagents is given in great detail.

The cytoplasm has, as a rule, no reticulate or fibrillar structure; though in *Spirogyra* and some other cases a certain amount of differentiation does occur. It is made up of three distinct substances:—the substances dissolved in the vacuoles or cell-sap; the *microsomes*, insoluble both in water and in the cytoplasm; and the mucilaginous constituent or *cytoplastin*; this is the only proteinaceous substance invariably found in the cytoplasm, except in the youngest cells. The chemical properties of these various ingredients are again gone into in great detail. The formation of vacuoles the author regards as the result of the separation of substances previously combined, the more soluble of these collecting in the form of drops within the less

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Cohn's Beitr. z. Biol. d. Pflanzen, v. (1887) pp. 1–244 (8 pls.).

soluble. The membrane which bounds the cytoplasm outwardly and inwardly is not distinguishable chemically from the rest of its substance, and is formed out of the cytoplastin. The cytoplastin is coagulable by hot water, but is altogether insoluble in it.

The following is a summary of the more important chemical reactions of the substances above described:—The plastins (chloroplastin and cytoplastin) are insoluble in concentrated potash-lye and in a 10 per cent. solution of sodium chloride; while all the nuclear substances are soluble in these reagents; the plastins are not digested either by trypsin or pepsin, while the nuclear substances are all dissolved, at all events by trypsin. Chloroplastin is distinguished from cytoplastin by swelling up strongly with a 1 per cent. solution of hydrochloric acid, by which the latter is precipitated; chloroplastin is insoluble, or swells up slightly in a 5 per cent. solution of sodium phosphate, in which cytoplastin swells up strongly or is entirely dissolved.

Among the nuclear substances, chromatin and pyrenin are distinguished by their great absorptive power for pigments; their respective solubility differs with various reagents; chromatin is rapidly, pyrenin only very slowly digested by trypsin. Amphipyrenin absorbs pigments much less rapidly than pyrenin; it dissolves with difficulty in a 10 per cent. solution of sodium chloride, while pyrenin is readily soluble in it; on the other hand it is soluble in a 1 per cent. solution of potash-lye, pyrenin only with difficulty. Linin and paralinin are distinguished by their strong power of swelling with various substances, including water: paralinin is digested by pepsin, while linin is not. Metaxin is distinguished from the plastins by being digested by pepsin and trypsin; and from the nuclear substances by swelling up or dissolving in a 1 per cent. solution of sodium chloride, in which the latter are completely insoluble.

Position of the Nucleus in Mature Cells.*—Observations made by Herr G. Haberlandt lead him to the conclusion that the position of the nucleus in mature cells is not arbitrary, but depends on its function as the bearer of the idioplasm which governs development, this idioplasm being invariably seated in the nucleus.

When any particular wall or part of a wall is more strongly thickened than the rest, the nucleus is usually in immediate contact with this wall, and is sometimes connected with it by a string of protoplasm. A good example of this is the aquiferous epidermis of many orchids, where the nucleus is usually in contact with the outer wall. In other cases, when the inner wall is the thickest, it is in contact with it. In the guard-cells of stomata it is invariably in apposition with the thickened ventral walls. The rule is strikingly exhibited also in cells containing cystoliths. In the branching palisade-tissue of some Ranunculaceæ and of *Sambucus*, the nucleus has a central position, and is connected with the thickened portions of the wall by strings and plates of protoplasm.

In young roots (*Pisum sativum*, *Triticum vulgare*) the root-hair originates from a protuberance of the portion of the wall immediately over the nucleus, or the young root-hair is connected with the nucleus by one or more strings of protoplasm. In branched hairs it lies in their basal portion.

In multinucleated unicellular plants (*Saprolegnia*, *Vaucheria*), branches always originate immediately over a nucleus placed close against the cell-wall. The process of regeneration which takes place in many species of *Vaucheria* is always intimately connected with the presence of at least one nucleus.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 205–12.

Albumen in the Cell-wall.*—Herr F. Krasser, following up the observations of Wiesner † on the presence of albuminoids in the cell-wall, discusses the value of the reagents at present used to determine the presence of albuminoids. He finds that they fail in either not staining all albuminoid substances, or they stain not only albuminoids, but also other substances resulting from their decomposition. This is the case even with Millon's reagent, which colours also tyrosin, hydroparacumaric acid, and phenol. The copper test, and sulphuric acid containing molybdic acid, are the least reliable of any. A new test for albuminoids is proposed, viz. alloxan.

As regards special tissues, in a very large number of plants examined, the author was unable to determine with certainty the presence of albuminoids in the cell-wall, either in the growing point of the stem or in the root. None was found in the cell-walls of the root-cap, while those of the cambium, pericambium, and phellogen were strongly coloured. In all the cases examined—sixty-two in number—the cell-walls of the epidermis gave the albuminoid reaction. This was also commonly the case with the elements of the soft bast; less often with those of the fundamental parenchyma and pith. In ten cases a positive result was obtained with collenchyma. With the endosperm the result varied in different cases.

As regards the source of the albuminoids found in the cell-wall, Herr Krasser comes to the conclusion, from the phenomena connected with its development, that they are not the result of infiltration, but have been formed in the course of its formation.

Permeability to air of Cell-walls.‡—By the use of the air-pump Herr E. Lietzmann has investigated the extent to which cell-walls, in various conditions, can become permeated with atmospheric air, carrying out the subject especially from a mathematical point of view. The objects specially examined were cork, lamellæ from the tissue of the leaf of *Peperomia magnifolia*, and lamellæ of the wood of *Pinus Laricio* and *P. sylvestris.*

With the pressures employed, cork was impermeable in the axial direction, while the cuticle of *Peperomia*, the walls of the tracheids of *Pinus*, and other cell-walls, were permeable. All cell-walls on which experiments were made were more permeable to air in a saturated than in a dry condition. The wood of *P. Laricio* was more permeable in the tangential than in the radial direction. In *P. sylvestris* open tracheid-bundles were met with as long as 22 centimetres, or perhaps longer. The living parietal utricle of protoplasm is altogether impermeable, or permeable only to a very slight degree.

Swelling and Double Refraction of Cell-walls.§—Herr S. Schwendener discusses this subject from an experimental and mathematical point of view. He agrees rather with the older view of Nägeli than with that of v. Höhnel,|| believing that the phenomenon in question is accompanied by shortening in the direction of one axis as well as by lengthening in that of another, as is shown by certain lines on the membranes. When the conditions of elasticity in the direction of these lines are different from those in a vertical direction, torsion must result. The phenomena connected with swelling are described in detail in the case of static-mechanical cells, of dynamic cells (bastlike stereids with transverse cleft-shaped pores), of cork-cells with cellulose-thickenings, and of the elongated cells of *Caulerpa.*

* SB. K. Akad. Wiss. Wien, xciv. (1887) pp. 118–55.
† See this Journal, 1886, p. 818.
‡ Flora, lxx. (1887) pp. 339–86 (1 pl.).
§ SB. K. Preuss. Akad. Wiss. Berlin, xxxiv. (1887) pp. 659–702 (4 figs.).
|| See this Journal, 1883, p. 90.

In connection with the relationship between swelling and double refraction, the author agrees with Zimmermann's statement * that all non-cuticularized cell-walls show such optical properties as if they were compressed in the direction of the strongest capacity for swelling, or with that of the strongest shrinking when dried; the strongest swelling takes place in the direction of the shortest axis of the ellipsoid of elasticity, the least in that of the longest axis, and a medium degree of swelling in that of the medium axis. This is shown in the cases of ordinary bast-cells with longitudinal pores, of specific dynamic cells, of dynamic hairs and pappus branches, of thick-walled cork-cells, and of *Caulerpa*. Molecular tensions, such as those assumed by v. Höhnel, do not occur in any direction, and the hypothesis that double refraction in starch-grains or cell-walls is caused by such tensions must be abandoned. Such double refraction is dependent on a different arrangement in different directions of the minutest particles (molecules or micellæ) of the substance. The author accepts, with some limitation, Nägeli's conclusion of the absence of optical susceptibility of cell-walls to traction or pressure. This is especially true of normal stereids.

With regard to any change in the optical properties of the cell-wall resulting from the imbibition of fluids, the author's experiments gave negative results.

Silicified Cells in Calathea.†—Dr. H. Molisch describes peculiar cells in the bracts of *Calathea Seemannii*, surrounding the vascular bundles, especially the bast-cells, completely filled by silica, or possibly by a silicate. They occur in such numbers as to form a complete coat of mail around the vascular bundles. The walls of these cells are not silicified.

(2) Other Cell-contents.

Structure of Chlorophyll-grains.‡—From an examination of the small chlorophyll-grains containing very large "grana," in the creeping stem of *Goodyera* (*Hæmaria*) *discolor*, Herr V. Chmielewsky confirms Schimper's and Meyer's hypothesis that the matrix (stroma) of the chloroplast is colourless, the colour residing only in the vacuoles or "grana."

He was also able to follow out accurately the development of the starch-grains. As these are being formed the chlorophyll-grain gradually increases in size, while its grana diminish; and finally the entire chlorophyll-grain, with its grana, altogether disappears. In mature starch-grains not the least protoplasmic remains of the chlorophyll-grain can be detected. The first layer of the starch-grain is formed on the periphery of the chlorophyll-grain, from where it gradually extends to the interior.

Hourly Variations in the Action of Chlorophyll.§—M. J. Peyrou, with the aid of a new instrument which he has lately had made, has investigated the variations in the action of chlorophyll. He finds that the function, at different hours of the day, is proportional to the intensity of the light. His experiments were always made with an atmosphere saturated with moisture in the case of terrestrial plants. Corresponding results were obtained with aquatic plants.

Starch-grains coloured red by Iodine.‖—Herr A. Meyer replies to Dafert's contribution on this subject, whom he charges with inaccuracy and confusion on the chemical side of the question. He epitomizes the

* See this Journal, 1885, p. 476.
† Verhandl. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 30–1.
‡ Bot. Centralbl., xxxi. (1887) pp. 57–9 (1 pl.).
§ Comptes Rendus, cv. (1887) pp. 240–3, 385–8.
‖ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 171–81. Cf. this Journal, *ante*, p. 424.

difference in the chemical and physical properties of starch-substance and amylodextrin; and states that none of the dextrins resulting from the action of ferments or acids on starch-substance are coloured by iodine. Erythrodextrins do not exist; even dextrins of high rotating power can be so completely purified that they are no longer coloured by iodine. A dextrin can be produced for which (α) D = 194·8, and which is nevertheless not coloured by iodine. Where the red colouring is exhibited, it results from an admixture of amylodextrin.

Proteinaceous bodies in Epiphyllum.*—Herr. V. Chmielewsky has reinvestigated the bodies found by Molisch in the parenchymatous and epidermal cells of the branches of *Epiphyllum* (*truncatum*), and corrects his description in one respect, stating that they are insoluble in alcohol. From their chemical reaction he regards them as of the nature of globulin, and believes them to be excretory rather than reserve-substances. He finds them in quite as large quantities in old as in young branches, and also that they are not used up when the plant is starved.

Carrotene in Leaves.†—M. A. Arnaud states that carrotene is always found in the leaves of plants in full vegetation. The amount is equal on an average to about 0·1 per cent. of the weight of the dried leaves, and it must exert a considerable influence on their colour.

Calcium oxalate in Aleurone-grains.‡—According to Herr A. Tschirch, the crystals of calcium oxalate found in aleurone grains of seeds are sometimes again completely dissolved when the seeds germinate, showing that they must have a function as reserve food-materials. This is especially well seen in the lupin. Herr Tschirch also describes the various crystalline forms which the calcium oxalate assumes in the aleurone-grains of seeds.

Nitrates and Nitrites in Plants.§—Dr. H. Molisch states that nitrates occur more abundantly in herbaceous than in woody plants, while in no single instance has he been able to detect the presence of nitrites, which are injurious to plants even in very dilute solutions, and are reduced by them with extraordinary rapidity. Nitrates can, on the other hand, remain weeks, or even months, within the cells of plants without being decomposed. The nitrates found in plants are never the result of the oxidation of nitrites or of ammonia salts in the cells, unless under the influence of bacteria, but are always absorbed as such from the soil.

Biological Import of Raphides.‖—Prof. E. Stahl calls attention to the less obtrusive protective features exhibited by many plants. Numerous points of external and internal structure are, he maintains, only fully understood when considered in relation to the fauna which would destroy the plants if not in some way protected. At present, however, he only notes that the abundant raphides in plants are not wholly to be regarded as useless excretions, but also as protections against snails and other destructive foes, which are at least thus restricted in their ravages. Snails have been observed to confine their voracity to those parts of certain plants where crystals were absent. *Arum maculatum*, usually regarded as poisonous, owes its burning and repulsive taste solely to the presence of very numerous raphides which penetrate the mucous membrane of the mouths of those animals which attempt to devour it.

* Bot. Centralbl., xxxi. (1887) pp. 117–9 (1 pl.). Cf. this Journal, 1886, p. 89.
† Comptes Rendus, civ. (1887) pp. 1293–6. Cf. this Journal, 1885, p. 670.
‡ SB. Gesell. Naturf. Freunde Berlin, April 19, 1887. See Bot. Centralbl., xxvi. (1887) p. 223.
§ SB. Akad. Wiss. Wien, May 5th, 1887. See Bot. Ztg., xlv. (1887) p. 454.
‖ Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 145–7.

(3) Secretions.

Secretion of Araucaria.*—MM. E. Heckel and F. Schlagdenhauffen have demonstrated an interesting fact in regard to the secretion of *Araucaria*. The secretions of Conifers are known to be oleoresins, consisting of an essential oil and of a resin. But in the section Araucarieæ, it would appear that the secretion is not a resin nor an oleoresin, but a resinous gum. The observations proving this interesting exception were made on a large number of *Araucarias*, so that the fact may be safely affirmed as true of the genus. The chemical investigations, the details of which need not be repeated, were based especially on the exudations of *Araucaria Cooki* R. Br. It is interesting to find a distinct genus thus marked off by chemical as well as morphological peculiarities.

(4) Structure of Tissues.

Aquiferous Tissue in the Leaves of Sansevieria.†—A similar function to that of the peculiar structures in the roots of austral Coniferæ is, according to Prof. F. W. C. Areschoug, exercised by certain cells with fibrous thickenings in several species of *Sansevieria*. Almost the whole of the internal fundamental tissue of the very thick leaves is transformed into aquiferous tissue, except a portion immediately surrounding the vascular bundles. The cell-wells of this tissue are very thin and porous, the pores having the form of a flat ring. The whole of the inner surface, even of the horizontal walls, is covered by slender branching fibre-like thickenings arranged spirally, which prevent them from contracting, so that they may serve as a perpetual reservoir of water.

Laticiferous Vessels and Assimilating System.‡—From an examination of the orders Apocynaceæ, Asclepiadeæ, Euphorbiaceæ, Campanulaceæ, and Lobeliaceæ, Sigg. J. R. Pirotta and L. Marcatilli endeavour to trace the relationship between the laticiferous vessels and the assimilating tissue in the leaves. They find that, in the greater number of cases, the laticiferous vessels follow the course of the veins, and form in the leaves a more or less close network. In other cases they leave the veins and spread through the mesophyll. In all cases the authors believe that the laticiferous vessels are so arranged as to receive the products of assimilation from the parts where they are elaborated and transport them to the different parts of the plant.

Sieve-tubes.§—Dr. A. Fischer defines a sieve-tube as active so long as, on making a section of the living plant, it forms "Schlauchköpfe," i. e. so long as the sieve-pores are open and the contents fluid. Of active sieve-tubes he distinguishes three kinds, viz. (1) With coagulable sap; the contents consist of a slight parietal layer of protoplasm, and a clear sap which coagulates on heating (Cucurbitaceæ). (2) With mucilage; the contents consist of a delicate parietal layer of protoplasm with a larger or smaller admixture of mucilage, and a clear watery not coagulable sap (*Humulus*). (3) With starch-grains; the contents consist of a delicate parietal layer of protoplasm containing a small quantity of mucilage, and a clear not coagulable sap with starch-grains (*Coleus*). Most Dicotyledons belong to the third type; the rest, with the exception of Cucurbitaceæ, to

* Comptes Rendus, cv. (1887) pp. 359–60.

† SB. Bot. Verein Lund, March 17, 1887. See Bot. Centralbl., xxxi. (1887) p. 258.

‡ Annal. Ist. Bot. Roma, 4 pp. See Bull. Soc. Bot. France, xxxiv. (1887), Rev. Bibl., p. 51.

§ Ber. K. Sächs. Gesell. Wiss., 1886, 48 pp. and 2 pls. See Bot. Centralbl., xxxi. (1887) p. 8. Cf. this Journal, 1886, p. 268.

the second. In all, the sieve-plates are covered by a very thin layer of callus, which is either completely covered with mucilage, or only at the margins of the sieve-pores on both sides of the plate.

In the development of all three types, drops of mucilage are first formed in the parietal protoplasm. In the Cucurbitaceæ these are soon again absorbed; in other cases they remain; in the third type the starch-grains are formed at the same time. The author agrees with Russow that the callus is separated from the contents of the sieve-tube and not from the cellulose-plate. In Cucurbitaceæ the sieve-plate is slightly pitted before the formation of the callus, but the pitting is in all cases a secondary process after the tubes have emerged from the condition of cambium-cells.

The obliteration or cessation of the functions of the sieve-tubes, commences with changes in both the contents and the sieve-plates, which vary in different plants. They finally become completely empty; when they contain starch-grains, these are the last to disappear. The pores also become completely closed.

Dr. Fischer affirms that the sieve-tubes are in connection with one another and with the conducting cells, but not with the cambiform.

Effect of Stimulation on Turgescent Vegetable Tissues.*—Miss A. Bateson and Prof. F. Darwin have tried a series of experiments on the effects of water and other reagents on the increase in length of the turgescent pith of a growing shoot when freed from its surrounding tissues. The plants experimented on were *Helianthus tuberosus* and *H. annuus*. The increase in length was measured by means of an auxanometer-lever. One end of the pith was attached to the bottom of a narrow glass jar, the upper end being connected, by means of a thread of plaited silk, with the short arm of the lever. The following is a summary of the chief results.

Turgescent pith placed in water increases in length, at first slowly, then more quickly; and then again the rate of increase becomes more slow. The rate of increase in length increases as the temperature of the water rises, reaches an optimum, and suddenly falls as a temperature sufficient to cause flaccidity is approached. The following reagents cause distinct acceleration:—Alcohol, ether, ammonia, hydrocyanic acid. The first three produce a very temporary effect, whereas prussic acid has a prolonged action. The following reagents produce retardation:—Acetic acid, hydrochloric acid, and probably nitric acid. Dilute solutions of quinine chloride and of carbolic acid produce a remarkably rapid shortening of the pith.

Formation of Tyloses in the interior of Secretory Canals.†—Mdlle. A. Leblois states that she has lately made a series of researches on the origin and development of secretory canals. In the course of the investigation which was made on the branches of *Brucea ferruginea*, cells projecting into the interior of the secretory canals were observed. These cells were sometimes in the form of a hair or papilla, but more often they were club-shaped, and were formed by the projection of the cells at the border of the canal. Afterwards these cells were observed to divide by transverse septa. In the older branches, on account of their number, these cells somewhat filled up the canal; they then took on the appearance of tyloses.

The author concludes by stating that two types of tylosis might be distinguished: firstly, those that occur in the old vessels and which were described in 1845, and, secondly, those shown to occur in old secretory canals.

* Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 1–27 (5 figs.).
† Bull. Soc. Bot. France, xxxiv. (1887) pp. 185–6.

Super-endodermal Network in the Root of Rosaceæ.*—M. P. van Tieghem has already described the structure of the cortical layer of the young root in Coniferæ and Cruciferæ in contact with the endoderm, which is furnished with a network of lignified thickenings. In this paper he continues this work with the Rosaceæ.

In a young root of the pear, each cell of the super-endodermal layer has a lignified thickening-band in the middle of the radial and transverse walls. This band projects towards the interior in a semicylindrical form, and incloses a rectangular cell. From each side of the common partitions the two bands correspond exactly, and unite to form one thick cylindrical band. The longitudinal and transverse bands constitute a network with rectangular meshes, and this forms a strong support for the young root.

Of forty genera of Rosaceæ examined by the author, thirty possess a super-endodermal network, and ten are destitute of one. These ten genera are confined to the three tribes Potentilleæ, Poterieæ, and Quillajaeæ; but the first two also contain genera which possess a network. Among the Poterieæ, for instance, the Sanguisorbeæ have a network, while the Pimprenelleæ (*sic*) are destitute of one. Among the thirty genera of Rosaceæ which possess a network, various slight modifications are to be found; these the author describes in detail.

In conclusion, it will be seen that there are now three great families of plants in which the young root is provided with a super-endodermal network—the Coniferæ, Rosaceæ, and Cruciferæ. In the latter case only the meshes of the network are reticulated.

Anatomical structure of the wood of Leguminosæ.†—Herr A. Saupe finds that the separation of the order Leguminosæ into the three suborders Papilionaceæ, Cæsalpinieæ, and Mimoseæ, does not correspond to any general differences in the structure of the wood. All the species of particular tribes do, on the other hand, present common characters in this respect, as, for example, in the tangential section of the medullary rays. This is especially the case in the tribes Genisteæ, Dalbergieæ, and Galegeæ. Certain nearly related genera exhibit also a more exact resemblance in their microscopical characters, as, for example, *Gymnocladus* and *Gleditschia* among Cæsalpinieæ, and *Colutea*, *Halimodendron*, and *Caragana* among Papilionaceæ, and especially *Wistaria* and *Robinia*, which is the more remarkable from the difference in habit of these genera. Only rarely could the histological character of the wood be used in the discrimination of species, but this occurs in the genera *Cassia*, *Cercis*, *Podalyria*, and *Sophora*. The climbing *Acacia sarmentosa* agrees altogether in the structure of its medullary rays with the rest of the genus.

(5) Structure of Organs.

Formation of Roots in Austral Coniferæ.‡—Prof. S. Berggren describes a structure of the roots peculiar to certain Coniferæ from the southern hemisphere. In *Podocarpus* there are formed, along all the younger branches of the roots, two or three moniliform rows of globular or elliptical secondary roots, of constant length in each species, varying in different species from 0·25 to 2 mm. They consist, for the larger part, of spongy cortical tissue, the cell-walls of which have spiral or reticulate thickenings, which prevent their shrivelling up when dry. The function of these peculiar bodies appears to be the same as that of the aerial roots of

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 221–3.
† Flora, lxx. (1887) pp. 259–68, 275–82, 295–316, 323–35.
‡ SB. Bot. Verein Lund, March 17, 1887. See Bot. Centralbl., xxxi. (1887) p. 257.

Orchideæ, to serve as a storehouse for water. These structures attain their largest development in *Araucaria*, where their branching gives them a coral-like appearance. In the Cupressineæ of the southern hemisphere they are altogether wanting. Northern representatives of those genera which are most abundant south of the equator, display this structure to a modified extent only.

Swellings on the Roots of Papilionaceæ.*—Herr A. Wigand gives a *résumé* of the extensive literature on this subject, and sums up in favour of Brunchorst's view, that the so-called "bacteroids" are true bacteria.

Root-tubers of Leguminosæ.†—Herr A. Tschirch describes a peculiarity in the structure of the digitate tubers in the root of *Vicia sepium*, in which there is no suberous sheath to prevent the passage of the food-material into the surrounding empty tissue. The same result is attained by the separation of a layer of parenchymatous cells, which divide by tangential walls into tabular cells, and the walls of these cells become strongly suberized.

Structure of Chenopodiaceæ.‡—From the examination of the comparative anatomy of the stem and root of a large number of species of Chenopodiaceæ, belonging to many different genera, Prof. St. Gheorghieff comes to the following general conclusions:—

The abnormalities in the stem and root are more frequent in the latter than in the former, being often found in the root and not in the stem, but never in the stem when they are not also in the root. They are especially characteristic of perennial, and more particularly of climbing species, or of the perennial parts, sometimes not making their appearance till the third or even the fourth year. It is only rarely that neither stem nor root displays abnormalities in its structure. The main point of the exceptional structure is the large number of concentric secondary zones of increase in thickness, and the separation of the phloem into separate bundles distributed over the whole of the transverse section of the stem and the root.

There are some species in which the peculiarities of structure are so specialized that they can be distinguished from one another by the stem or root only. This is the case with *Haloxylon Ammodendron*, *Halostachys caspia*, *Grayia Sutherlandi*, *Suæda fruticosa*, and *Kochia prostrata*.

A general review of the structure of the natural order is given, with especial reference to the genera *Bosea*, *Kochia*, *Suæda*, *Halostachys*, *Eurotia*, *Haloxylon*, *Hablitzia*, *Boussingaultia*, *Basella*, and *Grayia*.

Biaxial Shoots of Carex.§—While the mode of growth of the majority of species of *Carex* is a uniaxial sympodium, Herr A. Callmé points out that in two species, *C. digitata* and *ornithopoda*, the primary shoot remains sterile, producing leaves only, while in its axis arise leafless and fertile lateral shoots of the second order.

Development of the Suckers of Thesium humifusum.‖—M. Leclerc du Sablon states that the structure of the suckers of *Thesium humifusum* has been studied with care by MM. Chatin and Solms-Laubach. Their development has, however, not been followed. In the neighbourhood of the growing point of the root a slight swelling can sometimes be noticed, analogous

* Wigand's Bot. Hefte, ii. (1887) pp. 88–97 (1 pl.). Cf. this Journal, *ante*, p. 429.

† SB. Gesell. Naturf. Freunde Berlin, April 19, 1887. See Bot. Centralbl., xxxi. (1887) p. 224. Cf. this Journal, *ante*, p. 429.

‡ Bot. Centralbl., xxx. (1887) pp. 117–21, 150–4, 183–7, 216–9, 245–9, 280–3, 328–30, 359–65, 369–80; xxxi. (1887) pp. 23–7, 53–7, 113–6, 151–4, 181–5, 214–8, 251–6 (4 pls.).

§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 203–5.

‖ Bull. Soc. Bot. France, xxxiv. (1887) pp. 217–21.

to that of a very young root. If a transverse section be made in the middle of the swelling, it will be seen that the tissues of the root are modified. Some cells of the pericycle elongate radially, and divide by radial and tangential septa; the cells composing the endoderm and internal portion of the cortex also elongate and divide. In the middle portion of the cortex a separation is also produced. Thus it will be seen that, as in the case of *Melampyrum*,* the pericycle, endoderm, and cortex take part at the same time in the new formation. From this point the growth of the sucker is rapid. The author concludes by stating that the development of a sucker differs from that of a root, and its structure only accords with that of a root in a few characters.

Colour of Coloured Leaves.†—Prof. T. W. Engelmann has investigated the cause of the colouring of the leaves in a large number of plants in which they are normally coloured, and its relationship to the decomposition of carbon dioxide in the light.

The colouring may depend on two different causes: on a variation in the colour of the assimilating chromophyll-bodies, or on the occurrence in the leaf of special pigments in addition to the normal chromoplasts. In the first case, the colouring appears to be invariably light, and either pure yellow or yellow-green, with easy transition to ordinary chlorophyll-green; in the second case it is usually red-brown, dark purple-brown, purple-red, or violet. In the first group of cases there appears to be frequently a definite quantitative relationship between the amount of colouring matter and that of chlorophyll. The colouring matter of the leaves of the yellow variety of *Sambucus nigra* was especially investigated and described. The yellow tint does not appear to be due here to a pure xanthophyll, but to a mixture containing a small quantity of true chlorophyll and of chlorophyllan. In more refrangible light (about $\lambda = 0\cdot53\ \mu$), the yellow cells decompose relatively, if not absolutely, more carbon dioxide than the green, while in red and green light the green cells decompose, both absolutely and relatively, more than the yellow.

In the second group the seat of the pigment is usually the cell-sap; less often the cell-wall. In the latter case the colouring is mostly confined to small portions of the surface, causing variegated leaves. Of leaves coloured by a soluble pigment, about fifty kinds were examined. These may be divided into two groups, connected with one another by intermediate forms: those in which the leaves are normally coloured during the whole or the greater part of their existence, and those which are coloured only when young. The colouring is, in both these cases, usually, but not always, spread over the whole surface of the leaf.

With regard to the distribution of the pigment in the component tissues of the leaf, all the cells of the epidermis and its appendages, as well as the assimilating parenchyma, may contain coloured sap. In other cases only some of the epidermal cells of definite position are coloured. A red pigment is commonly contained exclusively in the assimilating tissue, especially in the palisade cells. That cells containing a purple sap can decompose carbon dioxide as energetically as those which contain pure chlorophyll is shown, among other examples, by the great size attained by the copper-beech, and the vigour of growth of the various species of *Coleus*. Neither the size, form, arrangement, colour, nor number of the chlorophyll-grains presents any peculiarity in such leaves. Only those rays appear to be absorbed by

* Cf. this Journal, *ante*, p. 778.

† Bot. Ztg., xlv. (1887) pp 393–8, 409–19, 425–36, 441–50, 457–70 (2 pls.), and Arch. Néerland. Sci. Exact. et Nat., xxii. (1887) pp. 1–57 (2 pls.).

the pigment which are of the least importance in assimilation. A number of tables of wave-lengths and curves complete the paper.

Yellow Spots on Leaves.*—Dr. P. Sorauer has investigated the cause of the yellow spots on the leaves of a number of plants, and finds it due in all cases to a stretching of the cells of the mesophyll. The cells are at first empty, but become afterwards filled with a brown substance resulting from the breaking up and disintegration of the chlorophyll-grains in adjacent cells.

Bud-scales.†—Herr R. Cadura classifies the coverings of the buds of exogenous trees under four types, viz. (1) Collenchymatous coverings, consisting of elongated collenchymatously thickened parenchyma; (2) Parenchymatous coverings; (3) Periderm-like coverings, with parenchymatous cone and suberized apex; (4) Stereid-like coverings, with specific mechanical tissue. In the seventeen species examined, he finds one or other of these modes present, according to the need of the species for protection against excessive evaporation, radiation, cold, &c.

The casting-off of the bud-scale is brought about by the formation of a zone of tissue at their base, the *phelloid*, the cells of which contain large quantities of starch and granular protoplasm, and in which intercalary growth takes place owing to the traction exercised by the swelling bud.

Gentians.‡—Prof. T. H. Huxley gives the results of a survey of the natural order Gentianaceæ. Confining himself almost entirely to the study of the structure of the flower, he was able to distingush some seven or eight modifications; and these were found to fall into two series, characterized by a peculiar disposition of the mechanical organs. The corolla presents a gradation of forms from the rotate, or rather stellate, condition, through the campanulate, to the extreme infundibuliform character. In one of these series the nectarial cells are situated on the inner surface of the cup, from the edge of which the lobes of the corolla proceed, and towards its basal end. The Gentianaceæ of this series the author terms *Perimelitæ*. In the other series there are no such patches of secreting cells visible on the corolla; but in many members of the series there is a zone of such cells, encircling the base of the ovary. These are termed *Mesomelitæ*.

In the series of the *Perimelitæ* four modifications of floral structure are discernible, and about the same number in the *Mesomelitæ*. The author gives names to each of these groups, and traces their relationship one to another, and also the geographical distribution of each.

Inflorescence of Typha.§—From a comparison of the structure of the inflorescence in the few species of *Typha*, Dr. M. Kronfeld supports Celakovsky's view that it is essentially of the same type of structure as that of *Sparganium*, and that the distinct zones of flowers are in reality axillary shoots. Even the female partial inflorescence is composed of several, or at least of two, internodes.

Axis of the Inflorescence. ‖—Dr. E. Dennert discusses in great detail the variations in the anatomical structure of this organ, to adapt it to different conditions. At the time of flowering the passage from the leafy

* Forsch. a. d. Geb. d. Agriculturphysik, ix. pp. 387–96. See Bot. Centralbl., xxxi. (1887) p. 279.

† Cadura, R., 'Physiol. Anat. d. Knospen-decken dikotyler Laubbäume,' 42 pp., Breslau, 1887. See Bot. Centralbl., xxxi. (1887) p. 87.

‡ Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 101–24 (1 pl.).

§ SB. K. Akad. Wiss. Wien, xciv. (1887) pp. 78–108 (1 pl. and 2 figs.). Cf. this Journal, *ante*, p. 114.

‖ Wigand's Bot. Hefte, ii. (1887) pp. 128–217 (1 pl.).

stem to the immediate flower-stalk is marked by a decreased development of tissue, a rapid diminution in the number of bundles, and reduction of the pith. When the fruit is ripe the difference consists only in a diminished number of bundles and reduction of the pith, together with the absence of secondary vessels. Up to the period of ripening, the mechanical elements within the inflorescence are becoming gradually strengthened, which may take place either in the woody parenchyma or in the hard bast. In other cases, an extra-cambial sclerenchymatous ring or other form of sclerenchyma, makes its appearance, or a secondary sclerosis takes the place in the pith. The conducting tissue is also strengthened, and in some cases the cortical tissue. Not unfrequently the fruit-stalk is thickened immediately beneath the fruit.

Comparative Anatomy of Flower- and Fruit-stalks.*—Herr F. Besser classifies under four heads a large number of flower- and fruit-stalks examined by him, viz. (1) The flower-stalk has no mechanical tissue and the fruit-stalk only bast (*Linum usitatissimum*, *Prunus Cerasus*, *Platycodon grandiflorus*, Monocotyledons); (2) The flower-stalk has collenchyma, the fruit-stalk also bast (*Cucurbita Pepo*, *Citrullus vulgaris*, Papaveraceæ); (3) The flower-stalk has collenchyma, the fruit-stalk also libriform (*Campanula lactiflora*, *Scabiosa*, *Asterocephalus brachiatus*); (4) The flower-stalk has collenchyma, the fruit-stalk also libriform and a much smaller quantity of bast (*Malvaceæ*, *Solanaceæ*). *Asparagus officinalis* stands alone with its strongly developed sclerenchymatous tissue.

Bast-cells with vertical transverse walls are common; libriform fibres also occur. Notwithstanding the temporary duration of these organs, it is not uncommon to find a more or less complicated assimilating system.

Blossom on Old Wood.†—Dr. P. Esser remarks that many plants, especially tropical ones, produce flowers on parts of the wood which are several years old. After enumerating examples, he refers to Wallace's suggestion that flowers so produced near the stem, and under the shadow of the leaves, are for fertilization by the shadow-loving butterflies of tropical forests, and also to Johow's belief that by flower-bearing on old and hard parts, a plant is enabled to bear the weight of much larger and heavier fruits that it could otherwise support. He then gives the details of his own experiments on *Cercis*, *Goethea strictiflora*, *Theophrasta*, *Ficus Roxburghii*, and *Chrysophyllum Cainito*. He treats, in each case, of the anatomy of the wood; of the formation of a larger number of buds than is common; of the way in which these buds develope further; and of the manner in which their connection with the vessels of the stem is ultimately recovered.

The conclusions from these observations he sums up as follows:—

(1) There is no such thing as the production of adventitious buds upon wood whose development is once completed; but flowers appearing on old wood come rather, as Johow correctly indicated, from early formed buds which have been resting.

(2) With regard to the formation of these buds, which are all placed in the axils of leaf-shoots, we must distinguish between the following cases:—

(*a*) In each leaf-axil several buds are formed in series, most of which produce inflorescences after shorter or longer periods of rest. (*Chrysophyllum.*)

* Besser, F., 'Beitr. z. Entwickelungsgesch. u. Vergleich. Anat. v. Blüten- u. Frucht-stielen,' 32 pp., Lössnitz, 1886. See Bot. Centralbl., xxxi. (1887) p. 93.
† Verh. Naturh. Ver. Bonn, xliv. (1887) pp. 69–112 (1 pl.).

(b) In each leaf-axil a bud is placed, which in turn produces other buds in the axils of some of its lower leaves. These, often simultaneously with their mother-bud, are applied to flower-bearing after rest during several years. (*Ficus Roxburghii.*)

(c) In each leaf-axil two or more buds are placed in a row, which, on their part, form other buds in the axils of their leaves, the lower ones placed on the production of the leading shoot, and these buds appear one after another. (*Theophrasta, Goethea.*)

(d) In each leaf-axil a meristem is formed, from which, very slowly, it would appear that many buds are produced in rows, which develope after several years of rest.

(3) In some cases, not only single inflorescences are produced, but flowering shoots, that continue to blossom for many years.

Stipules and Petals.*—Observation of the stipules and flowers of the rarely flowering *Magnolia Frazeri* has confirmed Mr. T. Meehan in the conclusion previously arrived at by him that the petals of most flowers should be considered enlarged stipules, or thinly dilated bases of petioles, rather than modified leaves. This is especially the case with many kinds of rose. In the *Magnolia* the transition from stipules to petals is very well seen.

Amyloid Corpuscles in Pollen-grains.†—Investigating the starch-like structures found in the fovilla of pollen-grains, called by Saccardo "somatia," in upwards of two hundred plants, Sig. C. Zatti finds that some of them are coloured blue, others a light yellow by iodine-reagents. To the former, which vary greatly in size and form in different species, he applies the term *eusomatic;* to the latter, which are minute and globular, *notosomatic.* This difference does not correspond closely to any natural system of classification. Thus, among the Ranunculaceæ, the Clematideæ, Anemoneæ, and Pæonieæ are notosomatic, while the Ranunculeæ are eusomatic. All the species of Malvaceæ and Rosaceæ are eusomatic; while, on the other hand, all the Papaveraceæ, Cruciferæ, and Caryophyllaceæ are notosomatic.

Forms of Seedlings and the causes to which they are due.‡—In the second part of his paper on this subject, Sir John Lubbock continues his phytobiological observations as to the influence of the leaf on the cotyledon. He describes in detail the seedlings of various Onagrarieæ, some of which have very curious cotyledons. For instance, in *Œnothera Bistorta*, the cotyledons are long and linear, but suddenly widen at the end into a large orbicular expansion, which gives them a very peculiar appearance. In the case of unequal cotyledons, the instance of *Coreopsis Atkinsoniana* is well worth a little attention. The seeds are obovate, curved longitudinally, and compressed dorsiventrally, conforming to the interior of the fruit. The embryo is slightly bent, following the direction of the seed. Consequently the one cotyledon occupies the inner, the other the outer side of the curve; and the outer one is distinctly larger than the other. As to the position of the embryo in the seed, the genus *Plantago* is noticed, the position varying with the different species. Divided cotyledons are far from frequent; an instance occurs in the lime (*Tilia vulgaris*). The author concludes with some remarks on the form of the leaf in the tulip-tree, *Liriodendron*, which he regards as being determined by the exigencies of the folding up of the lamina and the stipules within the leaf-bud.

* Proc. Acad. Nat. Sci. Philadelphia, 1887, pp. 155–6.

† Bull. Soc. Ven.-Trent. Sci. Nat., iv. (1887) pp. 40–1.

‡ Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 62–87 (42 figs.). Cf. this Journal, *ante*, p. 112.

β. Physiology.*

(1) Reproduction and Germination.

Pollination of Pleurothallis ornatus.†—Mr. F. W. Oliver describes the peculiarities of the structure of the flower of this orchid. Each sepal is fringed with a row of cilia rendered vibratile by their very narrow base, and conspicuous from containing nothing but air. Their swaying backwards and forwards with every breath of wind renders them much more conspicuous to visiting insects. The labellum is small, and moves narrowly on its narrow neck when touched. Being quite hidden, this motion cannot be for the purpose of rendering the flower more conspicuous, as in the case of some other orchids, but appears to insure the insect's head being thrust against the stigma or pollinia.

(2) Nutrition and Growth.

Conditions of Assimilation.‡—Dr. N. Pringsheim communicates a preliminary account of his researches on the dependence of assimilation in green cells on the liberation of oxygen, and on the locality within the cell where the oxygen formed in assimilation actually originates. He notes the limitations of the prevalent method of gas analysis, and has striven by direct observation of the protoplasm to determine the seat and relations of the various functions. It seemed likely that the observation of protoplasmic movements in varying conditions of light and darkness, and in partial or total removal of oxygen, would afford a suitable starting-point for his researches. Previous experiments had forcibly suggested that observed differences in the assimilative energy did not in any way depend on differences in the number of chlorophyll-bodies, nor on the abundance of chlorophyll within these, but on the oxygen respiration of the protoplasm. This point Pringsheim sought further to investigate.

It has been known for long the green cells can break up carbonic dioxide in the absence of oxygen, where the carbonic dioxide is mixed with some innocuous gas. It is also known that protoplasmic movement is dependent on the presence of oxygen. If this be so, the protoplasmic movement in a green assimilating cell, in a medium free from oxygen, should not come to a standstill as long as it is illuminated, and the conditions of carbonic acid analysis fulfilled. With these facts in view, Pringsheim tried by experiment to answer the question whether a plant normally assimilating would cease to assimilate, without any alteration of the chlorophyll relations, if it were deprived, even for a short time, of the oxygen which is essential for respiration and plasmic movement, and whether it would recommence to assimilate whenever fresh oxygen was supplied. His experiments answered this in the affirmative.

The naked terminal cells of *Chara* leaves were placed in suspended drops in a microscopic gas-chamber; oxygen was as far as possible excluded; a continuous stream of carbonic acid and hydrogen passed through; and the amount of light caused to vary. In darkness the rotation of the protoplasm gradually ceases, the length of time before stoppage varying with the degree to which oxygen is successfully excluded, with the specific nature of the cell, and with the mass of the protoplasm. The final result is a state of complete "asphyxia," when the cell is dead, though still normal morphologically.

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

† Nature, xxxvi. (1887) pp. 303-4 (4 figs.).

‡ SB. Preuss. Akad. Wiss. Berlin, 1887, pp. 763-77, and Ber. Deutsch. Bot. Gesell. v. (1887) pp. 294-307.

If the cells be taken just before asphyxia, just when the protoplasm is ceasing to move at all, it will be found that they are no longer able to assimilate. They are still quite normal, but if now placed in an illuminated chamber, and supplied as before with carbonic acid, the rotation will not return. A little free oxygen restores the original state, but without this, in spite of the presence of light, chlorophyll, and carbonic dioxide, no oxygen is formed. This state Pringsheim calls "inanition" or "Ernährungsohnmacht." What has been noted in regard to its occurrence goes to show the dependence of assimilation on the absorption of oxygen.

But it is also a fact that the same phenomena of inanition occur when cells in similar circumstances are kept continuously in the light. Repeating the above experiment with continuous illumination instead of darkness, Pringsheim again observed the stoppage of rotation, and with it the cessation of the liberation of oxygen. The absence of free oxygen is again the condition of cessation of function; if a small quantity be introduced the life revives, if at least the inanition has not gone too far.

How is this to be explained in terms of the generally accepted theory of assimilation? *If the disruption of carbonic dioxide within the cell furnishes oxygen directly*, how should any assimilating cell suffer from want of oxygen? Pringsheim does not admit the usual assumption italicized above. His opinion is that the analysis of the carbonic dioxide in assimilation does *not* directly furnish oxygen, but that some other substance is formed, which, passing diosmotically to the surface, breaks up and liberates free oxygen. He criticizes the usual arguments based on the results of gas analysis. What the substance is which forms oxygen at the surface he is not yet prepared to state.

If this be so, the breaking up of carbonic dioxide and the liberation of oxygen are two processes, distinct both in space and time, the one occurring within the cell, the other at its surface. This view is supported by reference to the peculiar liberation of oxygen exhibited in darkness by both green and unpigmented cells towards death. The bacterium-method proves this fact incontestably. This liberation of oxygen in darkness, and quite independent of contemporaneous assimilation, may be termed "intramolecular liberation of oxygen," and, according to Pringsheim, the normal liberation is an essentially similar process, resulting from the disruption of an exosmosing substance.

He advances other arguments to show that we are not warranted in concluding, as has been hitherto done, that the presence of chlorophyll, light, and carbonic dioxide exhaust the conditions of assimilation, and that in estimating its amount no other factors but light-energy and the absorption of light by the chlorophyll have to be taken into account. Assimilation is, on the contrary, a physiological function of the protoplasm, and, like the movement, depends on the presence of free oxygen. Physiologists will look with interest for Pringsheim's detailed account of his investigations on this important subject.

Influence of Stretching on the growth of Plants.*—Dr. M. Scholtz has experimented on the influence on the growth in length of various plants —*Helianthus annuus*, *Tropæolum majus*, *Fagopyrum esculentum*, *Linum usitatissimum*, *Ipomæa purpurea*, *Sinapis alba*, *Cucumis sativus*—of weighting the growing stems with small weights, varying from 5 to 150 grammes. The possibility of heliotropic curvatures was carefully excluded.

He finds that the weight exercises on the growing stems two opposite influences, the one accelerating, the other retarding the growth. Both take

* Cohn's Beitr. z. Biol. der Pflanzen, v. (1887) pp. 323–64.

place at the same time, and their relative intensity determines whether the growth of the plant is accelerated, retarded, or remains the same. With more sensitive plants (*Ipomæa purpurea*, *Linum usitatissimum*, *Tropæolum majus*) the retardation is the stronger force; in those which are less sensitive (*Helianthus annuus*, *Cucumis sativus*, *Fagopyrum esculentum*) the retardation is perceptible to measurement only during the first days, when the weight is not nearly sufficient to rupture the tissues. With greater weight it cannot be measured even on the first day, although no doubt present. But while with more sensitive plants the retardation is permanent, with the less sensitive it disappears altogether, and after the first day a distinct acceleration is perceptible. Differences are also dependent on the amount of weight and the age of the plant. The growth of the plant in thickness is not reduced.

Reproduction of parts of Plants.*—Prof. F. W. C. Areschoug explains the tendency of some parts of plants to produce leaf-buds, and others roots, or of the same part to produce buds or roots under different conditions, by the hypothesis that buds are produced by those parts where there is a larger, roots by those parts where there is a smaller, accumulation of nutrient material; stems requiring a larger amount of nutriment than roots, in consequence of their larger size and greater complexity of structure. Thus in all trees the strongest shoots spring, not from the lower, but from the upper part of the previous year's shoot, where there is a larger supply of nutriment. Again, leaves, in which the supply of food-material is limited, as a rule produce roots only, but occasionally shoots from their basal portion.

(4) Chemical Changes (including Fermentation).

Formation of Albumen in Plants.†—According to Herr A. Emmerling, the total amount of nitrogen increases during the first period of growth of plants, especially in the leaves, until the commencement of the formation of the seeds. From this time it remains nearly constant in the leaves, but increases very rapidly in the fruits. The same is the case with the albuminoids. The non-albuminous nitrogen decreases, as a rule, as the amount of albuminoids increases, especially in the seeds and seed-vessels; while in the leaves it retains nearly the same proportion until the seeds are ripe, but increases again, during the last stage, owing to retrogressive metastasis.

Of the non-albuminous nitrogenous constituents, the amido-acids occur in especial abundance in the leaf-buds, floral organs, young seeds, and seed-vessels. In the leaves the amount of these acids remains constant for a long period, decreasing afterwards considerably; and this is the case also in the roots, seeds, and seed-vessels. From this it is seen that the amido-acids formed in plants are gradually transformed into other nitrogenous substances, and especially into albuminoids; and that the capacity of the plant to produce these acids decreases with age.

The course of the formation of nitrogenous substances in *Vicia Faba* appears to favour the hypothesis that the amido-acids are formed synthetically in the plant, especially in the leaves, and that they are conveyed to the plants where fresh formation of cells is taking place, such as the growing-points and the seeds, where they are then transformed into albuminoids. Since therefore it must be supposed that every young cell

* Bot. Centralbl., xxxi. (1887) pp. 186–8, 220–3.
† Landwirthsch. Versuchs-Stat., xxxiv. (1887) pp. 1–91. See Naturforscher, xx. (1887) p. 267.

constructs the albuminoids of its protoplasm out of amido-compounds, the formation of amido-acids is a very important item in the processes of metastasis.

Theory of Fermentation.*—Herr N. W. Diakonow has published the first part of a detailed account of his investigations on "the rôle of the fermentable nutritive substance in the life of the vegetable cells." His results will be summarized when his memoir is completely published.

He gives a clear historical introduction, resuming the progress of investigation in regard to fermentation from the researches of Thénard onwards. The various theories are briefly stated and compared.

The point on which his own researches were first concentrated was that of the influence of the composition of the nutritive substances transformed by the fungus on the nature of the gaseous transformations effected in the surrounding medium. The nature of the gaseous exchange with the external medium, as determined by the fungus, varies according to the chemical composition of the nutritive substances taken in, and differs of course markedly from what takes place in a simple combustion of the same substances. The relation between the quantity of oxygen absorbed and carbonic acid gas given off is determined by the proportion of oxygen in the nutritive substance. The author has sought to determine what relation obtains between the intensity of the liberation of carbonic acid in the absence of atmospheric oxygen and the quantity of oxygen in the nutritive material. The nutritive substances used were glucose, lactose, chinic acid, and tartaric acid. The fungi experimented on were *Penicillium glaucum*, *Aspergillus niger*, and *Mucor stolonifer*. A detailed description is given of the methods of research.

Alcoholic Fermentation.†—Prof. F. Delpino contests the modern view that the process of the fermentation of grape-sugar is a complicated one, in which succinic acid and glycerin are produced. These substances he believes not to be the direct products of fermentation, but, when found in the fermented liquid, to be degraded substances resulting from processes connected with the plastic or proteinaceous nutrition of the saccharomycete. He reverts to the older view that the effect of the ferment is to decompose the sugar directly into alcohol and carbon dioxide.

Prof. Delpino proposes to unite the forms known as *Saccharomyces cerevisiæ*, *minor*, and *ellipsoideus*, into a single species with the name *S. zymogenus*.

Chemical nature of Diastase.‡—Dr. C. J. Lintner contests Hirschfeld's statement that vegetable diastase is a special molecular modification of a particular germ. He asserts, on the contrary, that it contains nitrogen, and presents many points of similarity to the albuminoids, although it cannot be included under this group of substances. A more exact composition he is not able to give.

γ. General.

Adaptation of Plants to rain and dew.§—Prof. N. Wille records the results of a series of experiments for the purpose of determining the extent to which plants can absorb moisture through their aerial organs. The experiments were made on a number of species, by placing on them

* Arch. Slav. Biol., iv. (1887) pp. 31–61. Cf. this Journal, *ante*, p. 619.

† Nuov. Giorn. Bot. Ital., xix. (1887) pp. 260–2.

‡ Pflüger's Arch. f. Ges. Physiol., 1887, pp. 311–4.

§ Cohn's Beitr. z. Biol. d. Pflanzen, iv. (1887) pp. 285–321. Cf. this Journal, *ante*, p. 119.

drops of a 1 per cent. solution of lithium chlorate, and then determining, by means of the spectroscope, the extent to which the lithium was absorbed. The general results obtained were that water is absorbed so slowly and in such small quantities through these organs in comparison to the root, that it is without physiological value to the plant. This applies both to the ordinary leaves and to those parts which are designated by Lundström as specially constructed organs for the absorption of water.

Bleeding.*—Herr C. Kraus has examined the phenomena of "bleeding" in a number of species, both woody and herbaceous. He finds it to be invariably the case that when the plant is still attached to the soil by its root, the sap that first exudes from the wound is acid, while that which flows out later is either neutral or slightly alkaline; and the same is the case with cut shoots of the vine. The exuding sap is derived partly from the vessels and tracheïds of the wood, partly from the tissue immediately adjacent to the wound. A larger amount of bleeding takes place, as a rule, from younger than from older shoots.

Sachs's Vegetable Physiology.†—This most important work, an enlargement of a portion of Prof. J. von Sachs's 'Text-book of Botany,' is divided into six sections, viz.:—(1) Organography; (2) The External conditions of Vegetable life; (3) Nutrition; (4) Growth; (5) Irritability; (6) Reproduction. Under the head of Organography all the organs of a plant are classified under five heads, viz.:—(1) Root; (2) Shoot (including leaves); (3) Sporangia and Spores; (4) Archegonia; (5) Antheridia. In the section on Nutrition, a very large space is devoted to the phenomena connected with the absorption of water and the passage of nutritive material from one part of the plant to another; and the author adheres to his previous view that the transfer is effected through the lignified tissues.

B. CRYPTOGAMIA.

Symbiosis of a Bacterium and Alga.‡—Dr. M. Kronfeld objects to Tomaschek's description of the association observed between a *Bacillus* and a *Glœocapsa* as "symbiosis," § on the ground that it is not shown that the latter can derive any possible benefit from the former. He considers it more probable that the so-called bacillus is really the product of the breaking up of the filaments of an alga, a similar phenomenon having already been described by Zukal in the case of *Drilosiphon.*‖

Cryptogamia Vascularia.

Apospory.¶—Prof. F. O. Bower repeats in detail the phenomena connected with the aposporic reproduction already described by Drewry and himself in the ferns *Athyrium Filix-femina* var. *clarissimum*, and var. *plumosum elegans*, and in *Polystichum angulare* var. *pulcherrimum.* He points out that sporal arrest may occur, irrespective of the presence or absence of these substitutionary vegetable growths which so often accompany it. In the first and last varieties mentioned above the arrest in the development of the spores is, in the majority of cases, complete, not advancing

* Forsch. a. d. Geb. d. Agricultur-physik, x. (1887) pp. 67–144. See Bot. Centralbl., xxxi. (1887) p. 137.

† Sachs, J. v., 'Lectures on the Physiology of Plants,' translated by H. Marshall Ward, 836 pp. and 455 figs., Oxford, Clarendon Press, 1887.

‡ Bot. Centralbl., xxxi. (1887) pp. 350–2.

§ See this Journal, *ante*, p. 785.

‖ Ibid., 1884, p. 601.

¶ Trans. Linn. Soc. Lond.—Bot., ii. (1887) pp. 301–26 (3 pls.). See this Journal, 1885, pp. 99, 491; *ante*, p. 622.

beyond the appearance of the archespore. Substitutionary growths may take the form of (1) simple prolification; (2) sporophoric budding; or (3) apospory. The second of these forms includes the well-known development of bulbils on the fronds of some ferns. Apospory includes all those cases in which the substitutionary growth following sporal arrest results in the formation of organs having the characteristics of the oophore. This occurs naturally in the cases of the ferns above-mentioned, and may be induced artificially in mosses. In two of these there is a distinct transition from the sporophore to the oophore without the intervention of spores, and by a simple vegetative budding. In *A. Filix-fem.* var. *clarissimum*, the substitutionary growths which accompany the arrest of spore-formation are restricted to the sporangium itself; while in *P. angulare* var. *pulcherrimum*, the prothalloid growths may either proceed from the sorus, or may appear at quite distinct spots, and even on fronds which bear no sori at all, and comparable therefore in position to the common formation of sporophoric buds on the fronds of ferns.

The author concludes by comparing the aposporic phenomena in ferns to the cases of arrest which occur either exceptionally or nominally in mosses in *Chara* and in *Isoetes*, and to the phenomenon of parthenogenesis in flowering plants.

Structure of Mucilage-cells of Blechnum occidentale and Osmunda regalis.*—Messrs. W. Gardiner and Tokutaro Ito have examined the cells which secrete the slimy mucilage in *Blechnum occidentale*, wherein each hair of the terminal cell is glandular, and *Osmunda regalis*, where all the cells of the hair are usually secretory in function. They found that the mucilage arises from the protoplasm only, and not from the cell-wall, and that the whole process is distinctly intraprotoplasmic. The very words used by Langley in the description of certain animal secretory cells may be used of these ferns, for the cell-substance of the mature cells is composed of a framework of protoplasm connected at the periphery with a thin continuous layer of modified protoplasm (ectoplasm), while the meshes of the framework inclose two chemical substances at least, a hyaline substance in contact with the framework, and spherical granules imbedded in the hyaline substance. In other words, the mucilage is secreted in the form of drops, and each drop is further differentiated into a ground substance (gum mucilage), in which are imbedded numerous spherical droplets (gum).

Secretion commences by the breaking down of a portion of the innermost layers of the protoplasm at a number of contiguous but isolated areas; the result is the formation of small but rapidly growing mucilage drops. These last are at first watery and by no means well defined, but they soon become denser, and tannin is uniformly distributed throughout their structure. A delicate reticulation may now be observed in the drops, and this finally gives way to the appearance of numerous minute and brightly shining droplets, all separate and distinct.

Usually plant-cells are incapable of the active and repeated secretion which is seen in the animal secretory cells; and those of *Blechnum* and *Osmunda* die when they have formed their secretion; but in other cases, as e.g. the glands of *Dionæa*, it appears exceedingly probable that there are periods of rest and of repeated secretion, as in animals.

The secretion of the cells escapes by the rupturing of the cell-wall. In *Osmunda* the whole system is perforated by fine holes, which in the

* Ann. of Bot., i. (1887) pp. 27–54 (2 pls.), and Proc. Roy. Soc. Lond., xlii. (1887) pp. 353–5.

functional cell are filled by delicate strands of protoplasm; these establish a direct continuity between the protoplasmic contents of the various cells of the hair. The authors believe that, in their main features, the phenomena attending the formation of the secretion are very widespread, and limited neither to ferns nor to the particular case of secretion of mucilage.

Leaves of Ferns.*—Herr A. Vinge notices some peculiarities in the structure of the leaves of ferns, corresponding to the needs of the species as regards transpiration. In many thin-leaved ferns the mesophyll is almost entirely undifferentiated. Not unfrequently we find intercellular prolongations from the walls of the mesophyll-cells, especially in the neighbourhood of the stomata. The thick leaves of *Adiantum macrophyllum* have a very loose tissue; while, on the other hand, the mesophyll of *Polypodium ireoides* is very dense. The greatest differentiation of tissue was found in *Niphobolus Lingua*. Beneath the upper epidermis, a hypoderm consisting of two layers, then a palisade-parenchyma of from one to three layers with the ordinary isodiametrical layers within, the whole structure closely resembling that of a dicotyledonous leaf.

Muscineæ.

Fructification of Grimmia Hartmanni.†—M. Philibert describes this moss as resembling in the sterile state *Rhacomitrium sudeticum*, from which, however, it is distinguished by the tissue of the leaves. The perichætial leaves are of the same shape as the cauline leaves, only their base is rather more sheathed, and the tissue in the lower part is composed of rectangular cells, which are looser and more transparent. Rarely two fruits come from the same perichætium. The pedicel is three or four millimetres in length and twisted into a spiral; when moist, it is bent in an arc, so that the capsule is at an angle of about 45° with the vertical. The capsule is oval-oblong, very smooth, and is pale in colour with a reddish margin. Its length without the operculum from 1·5 to 1·7 mm., the diameter from 0·75 mm. The operculum is conical, subulate, and slightly oblique. The teeth of the peristome are linear-lanceolate, obtuse, entire, and of an orange-red colour; the two lower rows are very smooth. In conclusion, the author states that *Grimmia Hartmanni* ought to be placed among the true *Grimmiæ* near to *G. contorta* Wahl.

Sphagnaceæ of North America.‡—In a revision of the Sphagnaceæ of North America, M. J. Cardot states that that continent possesses several subtropical types not found in Europe, while only one European form (*S. Angstrœmii*) is at present absent from it.

Algæ.

Siphoneæ.§—The most recently published part of Prof. J. G. Agardh's Classification of Algæ refers to this group, in which he includes Dasycladaceæ and Valoniaceæ. The whole group is divided by him into six families as follows:—I. Bryopsideæ (*Bryopsis*, *Derbesia ?*). II. Spongodieæ (*Codium ?*, *Cladothele*). III. Udoteaceæ (*Chlorodesmis*, *Avrainvillea ?*, *Espera*, *Penicillus*, *Rhipocephalus*, *Callipsygma* n. gen., *Udotea*, *Rhipidosiphon ?*, *Halimeda*). IV. Valoniaceæ (*Valonia*, *Siphonocladus*, *Ascothamnion ?*,

* Bot. Centralbl., xxxi. (1887) pp. 290–3. † Rev. Bryol., xiv. (1887) pp. 49–52.

‡ Bull. Soc. Bot. Belg., xxvi. (1887) pp. 44–61.

§ Agardh, J. G., 'Till Algernes Systematik,' in Lunds Univs. Arsskr., xxiii. (1887) 180 pp. and 5 pls. See Mrs. Merrifield, in Nature, xxxvi. (1887) p. 313.

Trichosolen?, *Apjohnia*, *Struvea*, *Chamædoris*, *Dictyosphæria*, *Anadyomene*). V. Caulerpeæ (*Caulerpa*). VI. Dasycladeæ (*Dasycladus*, *Chlorocladus*, *Botryophora*, *Cymopolia*, *Neomeris*, *Bornetella*, *Halicoryne*, *Polyphysa*, *Acetabularia*, *Pleiophysa?*). Under *Avrainvillea* are included *Fradelia*, *Chloroplegma*, and *Rhipilia*. *Chlorodictyon* and *Codiolum* are altogether excluded.

The position of a number of these genera is provisional only, as in a considerable proportion of them the fructification and mode of reproduction are unknown, and for the same reason the delimitation of the families depends on characters which have no permanent value.

Growth of the Cell-wall and other phenomena in the Siphoneæ.*—In order to determine the question whether the growth of the cell-wall takes place by apposition or by intussusception, Herr F. Noll suggests the use of staining reagents which shall colour the fully formed parts of the cell-wall, while the parts in process of formation are left uncoloured. For this purpose he employed Berlin blue or Turnbull's blue, and applied the test to marine algæ in which the cell-wall grows with great rapidity, viz. *Caulerpa prolifera*, and species of *Bryopsis* and *Derbesia*. Having coloured the cell-walls already formed in the way indicated, their growth was then continued without further staining, when new colourless lamellæ of the cell-wall were found to be formed within those coloured blue, showing that the growth takes place by apposition only. In the transparent tubes of *Bryopsis* and *Derbesia* it was clearly seen that no increase of thickness took place by intussusception, and the same was the case also with the apical growth.

Herr Noll also investigated the function of the remarkable bands of cellulose within the tube of *Caulerpa*, which have generally been supposed to be for the purpose of strengthening. He found that they could have no appreciable value for this purpose, but that they display an extraordinary power of conduction in the direction of their length. Their object appears to be to promote the rapid passage of oxygen and other substances to the interior of the elongated cell, where they are required for respiration and other purposes.

The seat of the phenomena of heliotropism and geotropism displayed by these algæ was determined to be the parietal layer of protoplasm. In these plants of low organization external forces have much more direct influence than in higher plants, where morphological differentiation of organs for special purposes has already taken place.

Fresh-water Chætomorphas.†—Herr G. Lagerheim describes a new species of *Chætomorpha* (*C. Herbipolensis*) from water in a conservatory at Würzburg, and discusses also all the species of this genus that are brackish or fresh-water in contrast with the larger number of marine species.

Sensitiveness of Spirogyra to shock.‡—Mr. S. Coulter records the observation that if filaments of *Spirogyra* are cut through as carefully as possible with the sharpest instrument, eight or ten cells nearest to the laceration showed striking changes in their protoplasmic contents, the spiral bands of chlorophyll being broken up and exhibiting a tendency for the protoplasm to collect round certain definite centres. It was a noteworthy fact that the pond from which the *Spirogyra* was taken contained water which was always at a comparatively high temperature; under ordinary conditions the same sensitiveness was not displayed by the *Spirogyra*.

* Bot. Ztg., xlv. (1887) pp. 473–82.
† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 195–202 (1 pl.).
‡ Bot. Gazette, xii. (1887) pp. 153–7 (5 figs.).

Gynandrous Vaucheria.*—Under the name *Vaucheria orthocarpa* Herr P. F. Reinsch describes a new species, distinguished (in addition to other characters) by displaying gynandry. Besides the antheridium which springs laterally from the base of the oogonium, the latter organ produces a second antheridium at its apex, which developes precisely like a normal one. Only partial impregnation appears to take place in these cases, and the resulting oospore not to be capable of germination.

Fresh-water Algæ of New Zealand.†—Dr. O. Nordstedt describes the fresh-water algæ (except diatoms) brought from the hot-lake district of the Northern Island, New Zealand, and the Alps of the Southern Island—305 species and 55 varieties. They present but few novel features, and include 28 species of Œdogoniaceæ, 8 of Chætophoreæ, 1 of Chroolepidæ, 17 of Confervaceæ, 1 of Ulvaceæ, 8 of Pediastreæ, 4 of Protococcaceæ, 9 of Palmellaceæ, 3 of Volvocineæ, 2 of Vaucheriaceæ, 5 of Siphoneæ, 1 of Mesocarpeæ, 7 of Zygnemeæ, 152 of Desmidieæ, 5 of Rivulariaceæ, 7 of Sirosiphonaceæ, 7 of Nostoceæ, 10 of Oscillarieæ, 2 of Chamæsiphonaceæ, 10 of Chroococcaceæ. The new species include 1 of *Aphanochæte*, 1 of *Rhizoclonium*, 1 of *Desmidium*, 1 of *Hyalotheca*, 1 of *Micrasterias*, 5 of *Euastrum*, 5 of *Staurastrum*, 4 of *Xanthidium*, 9 of *Cosmarium*, 2 of *Triploceras*, 1 of *Closterium*.

Pores in Diatom-valves.‡—Herr O. E. Imhof claims to have detected, in large species of *Surirella* and in one of *Campylodiscus* from the Cavloccio lake in Upper Engadin, very fine canals in the wings, which open out at the edges in minute elliptical openings, through which pass protoplasmic filaments united into a continuous thread. These he regards as the true motile organs of diatoms.

Lichenes.

Apothecia of Lachnea theleboloides.§—Sig. F. Morini describes the development of the apothecia of this lichen, which resembles that of *Ascobolus furfuraceus*. On the mycelium appears a short thick branch, rich in granular protoplasm, which shows spiral curves to the extent of 2–2½ coils. At the free end of this branch is differentiated, by the formation of a septum, a terminal cell which soon assumes an ovate-spherical form. This is the mother-cell of the asci. The spirally coiled cell is segmented in the middle by a septum; the protoplasm passes out of the two cells thus formed into the terminal cell, and the basal cell dies away. At the base of the terminal cell now appears a conical thick-walled prominence, which is preceded by the formation of a number of hyphal branches, which have sprung from the mycelium, and have invested the carpogonium. A dense ball is thus formed, in the centre of which the carpogonium and terminal cell can scarcely be distinguished. These investing hyphæ form the principal mass of the apothecium, as well as the subhymenial layer and paraphyses. From the terminal cell spring a number of branches which terminate in asci. A number of the apothecia always remain small in the form of parenchymatous balls in which no carpogonium can be detected. Sig. Morini believes these to be the "spore-bulbils" of authors.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 189–92 (1 pl.).
† Bot. Verein Lund, April 18, 1887. See Bot. Centralbl., xxxi. (1887) p. 321.
‡ Biol. Centralbl., vi. (1887) p. 719.
§ Rend. R. Accad. Sci. Bologna, March 27, 1887. See Bot. Centralbl., xxxi. (1887) p. 332.

Double Lichen.*—Herr W. Zopf has observed upon *Physma compactum* and on other Collemacei, reddish-brown warty protuberances, which were found to be the imbedded flask-shaped perithecia of an Ascomycete, *Pleospora Collematum* n. sp. This fungus is not parasitic upon the lichen, but is in direct connection with the constituent alga, a species of *Nostoc;* and we have here a lichen made up by the symbiosis of two fungi with one alga. The mycelium of the *Pleospora*, easily distinguished by its yellow colour, penetrates the lichen to the base of the perithecia. When ready for fructification the perithecia emerge on the surface of the lichen in the form of reddish-brown protuberances; the thallus of the lichen surrounds the perithecia like a wall.

Microchemical reactions of Lichens.†—According to Dr. E. Bachmann, the chemical reaction characteristic of certain species of lichen, the appearance of a yellow colour, afterwards turning to red, when a drop of potash-ley is placed on the thallus, depends on the formation of very minute needle-like crystals, of a rusty or blood-red colour, collected in groups or in a dense felt. These are insoluble in glacial acetic acid, but are dissolved by concentrated hydrochloric acid with a yellow colour. This reaction occurs in *Urceolaria ocellata, Pertusaria lævigata, Lecidea lactea, L. Pilati, Lecanora subfusca* f. *chlarona, Aspicilia adunans* f. *glacialis, A. alpina, A. cinerea*, and *Parmelia acetabulum.* The yellow colour appears at once, the separation of crystals after a few minutes.

Hesse obtained from *Calycium chrysocephalum* a yellow crystallizable pigment, insoluble in and unchanged by potash-ley, to which he gave the name calycin. The same reaction is exhibited by *Physcia mediana, Candelaria vitellina, C. concolor*, and *Gyalolechia aurella.* Other microchemical tests are given, by which particular species of lichen can be distinguished from their nearest allies.

Emodin in Nephroma lusitanica.‡—In the medullary tissue of this lichen, Herr E. Bachmann finds a pigment closely allied in its products to chrysophanic acid, but still differing from it. It appears to be identical with emodin, known at present in the root of the rhubarb, and in the bark and berries of *Rhamnus Frangula.*

Introduction to the Study of Lichens.§—Mr. H. Willey's work under this title is a revised edition of his 'List of North American Lichens,' published in 1873, with an enumeration of all species discovered since that date, and descriptions of eleven new species. It contains also a condensed account of the main facts concerning the structure of Lichens and their classification. The plates represent the spores of North American genera.

Fungi.

Action of Pyrofuscin on Fungi.||—Herr P. F. Reinsch finds that a solution of pyrofuscin acts rapidly and destructively on living mould-fungi such as *Aspergillus.* He suggests that this discovery may have an important bearing in medicine, in the treatment of diseases due to parasitic fungi, such as croup; pyrofuscin being entirely without any injurious influence on living human tissues.

* Verh. KK. Zool.-Bot. Gesell. Wien, 1887 (1 pl.).
† Flora, lxx. (1887) pp. 291-4.
‡ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 192-4.
§ Willey, H., 'An Introduction to the Study of Lichens,' 43 pp., Suppl. and 10 pls. New Bedford, U.S.A., 1887. See Prof. W. G. Farlow in Amer. Journ. Sci., xxxiv. (1887) p. 75.
|| Deutsch. Chem. Ztg., 1887, 2 pp.

Identity of Podosphæra minor Howe, and Microsphæra fulvofulcra Cooke.*—Miss M. Merry states that, in *M. fulvofulcra* Cooke there is clearly a single ascus in each perithecium, thus placing it in the genus *Podosphæra.* It agrees with the description of *P. minor* Howe, thus necessitating the cancelling of *Microsphæra fulvofulcra* Cooke.

New Section of Chytridium.†—Under the name *Chytridium Zygnematis,* Herr F. Rosen describes a new species parasitic on species of *Zygnema,* especially *Z. cruciatum.* The swarmspores have a diameter of 3–4 μ, with a single cilium from six to ten times the length of the body. Each spore has a large eccentric oil-drop, and a less refrangible crescent-shaped body, probably composed of nuclein. On coming to rest the cilium shortens and winds itself round the spore, and then disappears, while the spore clothes itself with a thin and very extensible membrane. It then puts out a germinating tube, with a small vesicle at its apex, from which it branches into a mycelium within the host; on this are produced the nearly globular or slightly ovate zoosporangia, the formation of which is, under certain conditions, preceded by that of vesicles containing a drop of oil. Each sporangium is surmounted by a double crest of teeth or elevations, and contains from eight to sixty zoospores. The species is characterized by its great dependence on air, and has unusual capacity for resisting desiccation. It appears nearly allied in some respects to *C. Hydrodictyi;* in the mode of escape of the zoospores it resembles *C. Mastigotrichis.*

Herr Rosen proposes the establishment from this species of a new section of *Chytridium,* which he names *Dentigera,* with the following characters:—Unicellular *Chytridia* with a bladder in the cell of the nutrient alga, from which proceeds a branched mycelium, and a more or less nearly spherical zoosporangium, at the apex of which are (four) two-cleft teeth. The zoosporangium is either sessile on the portion contained in the nutrient cell, or one or two sometimes stalk-like vesicles are interposed. The swarm-spores are globular with an eccentric oil-drop and a single cilium. Resting-spores unknown.

To this section belong, in addition to *Chytridium Zygnematis, C. dentatum* n. sp., parasitic on *Spirogyra orthospira,* and *C. quadricorne* dBy., parasitic on *Œdogonium rivulare.*

Cladochytrium.‡—Nowakowski included under this genus some forms of Chytridiaceæ with terminal or intercalary zoosporangia borne on branches of a mycelium partially or entirely projecting above the surface of the host; the zoospores producing again a similar mycelium without conjugating. Other forms producing resting-spores were believed by de Bary to be stages of development of the same fungus; and this has now been confirmed by Dr. M. Büsgen, who has followed out the whole cycle in *Cladochytrium Butomi,* parasitic on the stem and leaves of *Butomus umbellatus.* The development is characterized by the formation within the host-cell of swellings, within which are stored substances which are subsequently used up in the production of hyphæ and of resting-spores. In the same nutrient cell will sometimes be produced two kinds of swarmspore: one penetrates into the host and produces plants which bear resting-spores; the other kind is transformed almost directly into a second generation of zoosporangia.

In *Cladochytrium Flammulæ,* parasitic on *Ranunculus Flammula,* and *C. Menyanthis* on *Menyanthes trifoliata,* Dr. Büsgen has been able at present to detect the formation of resting-spores only.

* Bot. Gazette, xii. (1887) pp. 189–91 (1 pl.).
† Cohn's Beitr. z. Biol. d. Pflanzen, iv. (1887) pp. 253–67 (2 pls.).
‡ Ibid., pp. 270–83 (1 pl.).

Lophiostoma.*—Herr F. Lehmann contributes an exhaustive monograph of this genus, belonging to the Sphæriaceæ. Together with *Glyphium*, *Lophium*, and *Mytillinidion*, it makes up the family Lophiostomeæ. The following is the diagnosis given by the author:—Perithecia carbonacea, globosa v. ellipsoidea, ostiolis pro ratione magnis, labiato-dehiscentibus v. poro rotundato pertusis instructa. Sporæ fusiformes v. oblongæ, rarius ovatæ, 2–12-cellulares, v. rarius muriformes, hyalinæ v. fuscæ. The species are all epiphytic, more often on dead than on living plants, as many as 15 species on *Salix;* the other three genera of the family are most common on Conifers. In most species the only internal organs of reproduction are the asci; in a few, spermatia also have been found. In one species only are pycnidia known, producing stylospores.

The number of species at present known, and described in this monograph, is sixty-eight, of which twenty-six are new.

Phalloidei.†—Herr E. Fischer gives a monograph of the eleven known genera and seventy-three species of Phalloidei, chiefly exotic. He divides them first into two groups, the Phallei and Clathrei. The Phallei are again divided into Phallei mitrati, composed of the two genera *Dictyophora* and *Ithyphallus* (the latter including our native *Phallus impudicus*), and the Phallei capitati, also made up of two genera, *Mutinus* and *Kalchbrennera.* The Clathrei include seven genera not sharply defined, viz.:—*Simblum*, *Clathrus*, *Colus*, *Lysurus*, *Anthurus*, *Calathiscus*, and *Aseroë.*

Peziza.‡—This genus, now numbering about 370 known species, has been split up into about 100 distinct genera. M. J. de Seynes proposes to reunite them as sub-groups of the old genns. Details are here given of the structure of several species.

P. tuberosa exhibits in its young mycelium the unusual phenomenon of dichotomy. Its hyphæ display one of the few examples among Ascomycetes of a parasitism or symbiosis with the cells of an alga, probably *Cystococcus humicola.* A difference in the mode of absorbing the nutriment from the host is exhibited, according as the parasitism belongs to the hyphæ of the mycelium or of the "cupule."

P. melastoma displays a peculiar mode of rejuvenescence in the cupule. If this organ is cut through, the uninjured hyphæ elongate themselves over the cut surface, and cover it with a young delicate tissue.

Helotium Willkommi.§—Dr. R. v. Wettstein gives a description of the geographical distribution of *Peziza* (*Helotium*) *Willkommi*, and the injury caused by it on larches. He regards it as nearly allied to *Helotium calyciforme*, forming a section of that genus, to which belong also *H. Abietinum*, *Ellisianum*, and *chrysophthalmum.*

Ptychogaster.‖—M. Boudier points out that the forms included under the genus *Ptychogaster* are nothing but species of *Polyporus*, in which there is a large development of conidia in the interior of the tissue, which causes the individual to become sterile. In this way he proposes for a conidial form of *Polyporus amorphus* the name *Ptychogaster citrinus; Ptychogaster albus* is identified with *Polyporus borealis* or *P. destructor*, and *Ptychogaster*

* Nova Acta K. Leop. Carol. Deutsch. Acad. Naturforscher, l. (1886) pp. 45–152 (6 pls.). See Bot. Centralbl., xxxi. (1887) p. 265.

† Jahrb. Bot. Gart. Berlin, iv. (1887). See Hedwigia, xxvi. (1887) p. 113. Cf. this Journal, 1886, p. 833.

‡ Seynes, J. de, 'Rech. pour servir à l'hist. nat. des végétaux inférieurs,' iii., part 2, Paris, 1886. See Bot. Centralbl., xxxi. (1887) p. 70.

§ Bot. Centralbl., xxxi. (1887) pp. 285–7, 317–21.

‖ Morot's Journ. de Bot., i. (1887) p. 7.

aurantiacus with *Polyporus sulfureus;* for the conidial state of *Polyporus vaporarius* the author proposes the name *Ptychogaster rubescens.*

Heterœcious Uredineæ.*—Mr. C. B. Plowright describes two new species of *Puccinia,* and also gives the results of some experiments on the Gymnosporangia.

Puccinia Phalaridis n. sp. The æcidiospores of this Uredine, known as *Æcidium Ari* Desm., occur on *Arum maculatum;* the uredospores and teleutospores on *Phalaris arundinacea.* The author states that it is specifically distinct from the plant described by Schneider as *P. sessilis.*

Puccinia arenariicola n. sp. The æcidiospores of this species occur on *Centaurea nigra;* the uredospores and teleutospores on *Carex arenaria.* It was conclusively demonstrated that *P. arenariicola* is distinct from *P. Caricis* and *P. Schœleriana.*

The author gives the details of some experiments on the Gymnosporangia, and states that the life-history of these fungi is not so simple a matter as the statements of Oersted would lead us to suppose.

Ustilago Treubii.†—Graf zu Solms-Laubach describes under this name a fungus which produces galls of two different kinds on *Polygonum chinense* in Java. One of these kinds of gall is composed of growths caused by the parasite proceeding from the cambium of the host. From the galls issue club-shaped outgrowths composed of parenchymatous tissue penetrated by an irregular string of meristematic vascular bundles. By the penetration into the tissue of a number of hyphæ proceeding from this structure a kind of capillitium is produced, among which are formed the minute spores, about 4 μ in diameter. This capillitium assists the dissemination of the spores by preventing their soaking by the tropical rain.

Fungus parasitic in Lecanium hesperidum.‡—M. R. Moniez finds that the parasite first seen by Prof. Leydig in the blood of *Lecanium hesperidum* is a fungus. He proposes for it the name of *Lecaniascus polymorphus;* its appearance varies considerably, according to the different stages of its mycelium. Its simplest stage is that of an ovoid body, 4–5 μ long, and it is then difficult to distinguish developed conidia or ascospores; in this stage budding is often observed. The mycelium sometimes presents a series of very distinct swellings, which the author regards as the homologues of conidia; in this condition the mycelium itself may be 50–60 μ in length. In highly developed individuals the mycelium, instead of being perfectly homogeneous, is entirely filled with a finely granular protoplasm; M. Moniez is inclined to think that this is a stage preparatory to the complete transformation of the mycelium into an ascus.

A somewhat similar fungus has been described by Metschnikoff in the blood of *Daphnia magna,* under the name of *Monospora bicuspidata,* and another by Bütschli from *Tylenchus pellucidus.*

Fungi parasitic on the Mulberry.§—Sig. A. N. Berlese enumerates as many as 176 species of fungus found on the mulberry in Europe and America, growing chiefly on the branches, and either parasitic or not. Of these 25 belong to the Hymenomycetes, 4 to the Discomycetes, 72 to the Pyrenomycetes, 27 to the Sphæropsideæ, 41 to the Hyphomycetes, and 2 to the Myxomycetes. No species belonging to the Hypodermiæ is known to grow on the mulberry, and the same is true also of the fruit-trees

* Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 88–100. Cf. this Journal, 1885, pp. 288, 503.

† Ann. Jard. Bot. Buitenzorg, vi. (1887) pp. 79–92 (1 pl.). See Bot. Ztg., xlv. (1887) p. 469.

‡ Bull. Soc. Zool. France, xii. (1887) pp. 150–2.

§ Bull. Soc. Ven.-Trent. Sci. Nat., iv. (1887) pp. 9–38.

belonging to the Aurantiaceæ. Of the Melanconiæ very few species are moricolous, and none of these are Italian.

Fungi parasitic on the Savin, Larch, and Aspen.*—Herr R. Hartig identifies *Cæoma pinitorquum*, parasitic on the savin, with *C. Laricis*, parasitic on the larch, and has established that both these species are represented by the teleutospore-form *Melampsora Tremulæ*, which hibernates on the aspen.

Colocasia Disease.†—The edible tubers of *Colocasia esculenta* are, in Jamaica, subject to a disease which Mr. G. Massee finds to be caused by the attacks of a hitherto undescribed fungus *Peronospora trichotoma*. It appears in the form of yellow spots corresponding to the vascular bundles, which are always first attacked, the mycelium spreading through the entire substance of the tuber along the cavities of the tracheids, from which it passes to the adjoining parenchyma. Two forms of reproductive bodies, conidia and resting-spores, have been met with; the former are produced only on hyphæ exposed to the air; the latter on threads in the substance of the tuber; the conidiophores form a delicate white bloom on the surface of the diseased tubers. The *Peronospora* is undoubtedly the cause of the disease, but is accompanied by two other fungi, *Heterosporium Colocasiæ* n. sp. and *Cephalosporium acremonium*, parasitic on the preceding.

New Disease in Vines.‡—MM. L. Scribner and P. Viala describe a new fungus, *Greeneria fuliginea*, parasitic on vines. It has made its appearance in vineyards in the United States of America, and is found to attack the fruit just before it reaches maturity. A coloration is noticed which is rose-coloured in the white varieties of fruit, and reddish-brown in the dark varieties; this extends by concentric zones. The mycelium, which is very abundant in the berry, is whitish, and much branched and septated. The only reproductive bodies observed by the authors are peculiar; their structure is intermediate between the pycnidia and conidiophores. On account of the colour of the spores this fungus belongs to the Phæosporeæ.

Tubercular Swellings on the Roots of Vicia Faba.§—Prof. H. Marshall Ward comes to the conclusion that the tubercles on the roots of *Vicia Faba* always contain a fungus, allied to the Ustilagineæ, which enters the root by the root-hairs. The ultimate branches of the hyphæ in the cells of the tubercle bud off gemmules, which are afterwards scattered in the soil. This process resembles the budding discovered by Brefeld in the Ustilagineæ. By means of cultures and observations the author found that the infection from the soil is probably due to these minute gemmules acting as spores.

Cohn's Cryptogamic Flora of Silesia (Fungi).‖—In the second part of Herr J. Schrœter's account of the fungi of Silesia, contributed to this work, we find the conclusion of the description of the Myxogastres.

The Schizomycetes he divides into Coccobacteria, Eubacteria, and Desmobacteria. Under *Micrococcus* he describes a new species (*M. sordidus*), and two under *Streptococcus* (*S. lacteus* and *S. margaritaceus*). From Friedländer's *Pneumoniecoccus* is founded the new genus *Hyalococcus*, with globular

* SB. Gesell. Morphol. u. Physiol. München, 1887, pp. 43–4. See Bull. Soc. Bot. France, xxxiv. (1887) Rev. Bibl., p. 76.

† Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 45–9 (1 pl. and 2 figs.).

‡ Comptes Rendus, cv. (1887) pp. 473–4.

§ Proc. Roy Soc. Lond., xlii. (1887) p. 356.

‖ Cohn, F., 'Kryptogamen-Flora v. Schlesien,' Bd. iii. Pilze; bearbeitet v. J. Schrœter. Lief. 2; Breslau, 1886.

or elliptical cells, single or in pairs, rarely in rows of 4–6, inclosed in simple, distant, sharply-defined capsules. Besides *H. Pneumoniæ*, he regards *Pleurococcus Beigelii* as a second species. Of *Sarcina* three new species are described: *S. paludosa* in the water of sugar-factories, *S. rosea* in bogs, and *S. lutea*. *Bacterium termo* the author regards, not as a distinct species, but as the short-rod form of several filiform bacteria. *Bacillus* furnishes the following new species:—*B. sanguineus* from bogs, *B. Lacmus* in greenhouses, *B. melleus* on fæces, *B. pallidus*, *brunneus*, *corruscans*, and *melanosporus* on potatoes, and *B. fusisporus* in the water from sugar-factories. Under Eubacteria a new genus (*Cystobacter*) is described, consisting of short rods imbedded in a gelatinous mass, afterwards connected into filaments. The gelatinous mass divides into irregular lumps, which are afterwards inclosed in solid horny envelopes. It comprises two species, *C. fuscus* on hare's dung, and *C. erectus*.

The Chytridiacei are divided into three families, the Olpidiacei, Rhizidiacei, and Zygochytriacei. Belonging to the last is a new genus, *Urophlyctis*, in which the zoosporangia are seated on the living cells of the plant, and only the tufts of rhizoids remain imbedded in it; the resting sporangia are formed within the host by the conjugation of two similar cells. To this genus belongs *Physoderma pulposa* Wallr. Several new species are described, belonging to this family.

The order Zygomycetes comprises the Mucorinei and Entomophthorei, the former being again divided into the Mucoracei, Chætocladiacei, and Piptocephalidei. The Mucoracei include the Mucorei (*Mucor*, *Phycomyces*, *Sporodinia*, *Thamnidium*), Pilobolei (*Pilaira*, *Pilobolus*), and Mortierellei (*Herpocladium*, n. gen., *Mortierella*). The Chætocladiacei comprise the single genus *Chætocladium;* the Piptocephalidei the three genera, *Piptocephalis*, *Syncephalis*, and *Syncephalastrum*, n. gen. Under Entomophthorei are included *Empusa*, *Entomophthora*, *Tarichium*, *Conidiobolus*, and *Basidiobolus*.

The new genera are thus characterized.—*Herpocladium*:—The twining uniformly thick sporangiophores develope, at the apices of the uniformly thick lateral branches, globular sporangia without a columella. The only species (*H. circinans*) was found on hare's dung. *Syncephalastrum*:—The capitulate sporangiophores, produced at the apices of branches, are densely covered with cylindrical sporangia, in which the spores are found in rows. The only species (*S. racemosum*) was found among *Aspergillus Oryzæ* on rice and bread.

The Oomycetes are divided into Ancylistacei (*Myzocytium*, *Lagenidium*), Peronosporacei (*Pythium*, *Cystopus*, *Phytophthora*, *Sclerospora*, *Plasmopora*, *Bremia*, *Peronospora*), and Saprolegniacei (*Leptomitus*, *Saprolegnia*, *Achlya*, *Aphanomyces*).

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—Parts 27 and 28 of this work are now published, elaborated by Dr. G. Winter, whose services to the publication are now lost by his death. In Part 27 the review of the suborder Sphæriaceæ is completed with the genus *Xylaria* (twelve species) and its allies, and to it is appended a very useful clavis of the genera. This is followed by a description of the species belonging to the small suborder Dothideaceæ, completing the Pyrenomycetes. In Part 28 the Hysteriaceæ are commenced with a general account of the order, with its families, Hysterineæ, Hypodermieæ, and Dichænaceæ (seventy-three species in all). This part finishes with a general description of the fourth order, Discomycetes, divided into the orders Pezizaceæ and Helvellaceæ, and of the suborder Phacidiaceæ.

Protophyta.

Micro-organisms.*—In his work 'Die Mikroorganismen,' Prof. M. C. Fluegge adopts the classification of de Bary and Frank, and passes in review all the pathogenic species of Hypodermii, Peronosporeæ, Pyrenomycetes, and Mucorini, as well as those of Schizomycetes. In the case of *Aspergillus fumigatus* and *glaucus*, he states that the spores, if injected in sufficient quantities into the veins of a rabbit or guinea-pig, rapidly cause death. If rabbits, pigeons, or other small birds are placed in an atmosphere holding *Aspergillus* spores in suspension, the bronchials and kidneys become rapidly filled with the mycelial filaments; and the same is the case with *Erysiphe* and *Oidium*. With Grawitz, the author identifies *Oidium lactis*, *Achorion Schœnleinii*, *Trichophyton tonsurans*, and *Microsporon furfur* as forms of the same species.

The Schizomycetes are classified by Prof. Fluegge under four principal groups, viz.:—(1) *Micrococcus* (including *Staphylococcus*, *Streptococcus*, *Diplococcus*, *Ascococcus*, and *Sarcina*); (2) *Bacillus* (including *Bacterium*); (3) *Spirillum*; and (4) a group allied to Nostocaceæ, comprising *Leptothrix*, *Crenothrix*, and *Beggiatoa*. Each of the first two groups is again divided into pathogenic and saprophytic forms. The phenomena connected with gelatin culture are dwelt on in detail with each species. The author inclines to the view of Koch and Cohn with regard to the genetic distinction of the various forms, rather than to that of Zopf.

Rose-tinted Growth on Fresh Water.†—Herr J. B. Schnetzler, confirming the observation of Dr. Harz, describes a red substance floating on the surface of the Lac de Bret (Switzerland) due to the coccus-form of *Beggiatoa roseo-persicina*. In the same lake he found the dead bodies of flies attacked by the slender colourless leptothrix-filaments of the *Beggiatoa*, accompanied by its blackish zooglœa-form. From this latter the leptothrix was found to spring directly without any intermediate bacillus-form.

Sulphur-bacteria.‡—Herr S. Winogradsky proposes this term for that group of non-chlorophyllous protophytes distinguished physiologically by the property of reducing sulphur out of its solutions. In this group he includes *Beggiatoa alba* and its varieties, *Monas Okenii*, *M. vinosa*, *Clathrocystis roseo-persicina*, *Sarcina sulphurata* n. sp. (possibly identical with *S. rosea*), *Ophidiomonas sanguinea*, and probably others. His observations were made chiefly on *Beggiatoa alba* obtained from natural sulphur-springs.

The author finds that the presence of sulphates, especially calcium sulphate, in the water, is not only advantageous, but is absolutely essential for the healthy growth of *Beggiatoa*; but that, although, under such circumstances, reduction of the sulphates and formation of sulphuretted hydrogen takes place, the *Beggiatoa* takes no part in this reduction; the source of the sulphur in its structure is invariably the oxidation of sulphuretted hydrogen already present in the water. He confirms Hoppe-Seyler's statement that it cannot maintain its existence without access of free air. It appears, however, to require much less oxygen than most organisms; and where the supply of air is abundant it rapidly perishes. An excess of sulphuretted hydrogen also destroys it. By culture-experiments the author

* Fluegge, M. C., 'Die Mikroorganismen,' 692 pp. and 144 figs., Leipzig, 1886. See Bull. Soc. Bot. France, xxxiv. (1887) Rev. Bibl., p. 77.

† Bot. Centralbl., xxxi. (1887) p. 219. Cf. this Journal, *ante*, p. 787.

‡ Bot. Ztg., xlv. (1887) pp. 489–507, 513–23, 529–39, 545–59, 569–76, 589–94, 606–10 (3 figs.).

determined that water containing calcium sulphate is not capable of sustaining the life of *Beggiatoa*, unless the sulphuric acid is at the same time being reduced to the condition of H_2S.

The granules of sulphur found in greater or less abundance in the filaments of *Beggiatoa* are not, as stated by Cohn, crystalline, but consist of amorphous masses of the pure element of a soft consistency. It is completely soluble in carbon bisulphide. As soon as the filaments are dead the sulphur at once assumes the crystalline form, large crystals, formed from the contents of several cells, breaking through the cell-walls.

With regard to the further chemical process which takes place in the filaments of *Beggiatoa*, Herr Winogradsky came to the conclusion that the sulphur is there subject to a process of oxidation, resulting in the production of sulphuric acid, which, passing into the surrounding water, forms sulphates with evolution of carbonic acid; and this process goes on very energetically within the filaments. This is regarded by the author as a kind of respiration; though whether it altogether takes the place of the ordinary respiration, consisting in the oxidation of carbon compounds, he was unable to determine. This organism appears, at all events, to be able to exist in water which contains but a very small amount of organic matter. The entire removal of sulphur either entirely destroys its life, or possibly induces a resting condition. The source of the sulphuretted hydrogen in the water appears to be the reducing effect on soluble sulphates of the process described by Hoppe-Seyler as the "fermentation" of cellulose.

Micrococcus ochroleucus.*—Herr O. Prove finds in human urine a new chromogenous micrococcus, in colonies about 2 mm. in size, at first, and when light is excluded, colourless, but assuming, on exposure to light, a sulphur-yellow colour. The pigment is entirely insoluble in water, but easily soluble in alcohol with a yellow colour. This *Micrococcus ochroleucus* n. sp. is most easily cultivated on nutrient substances containing a considerable quantity of albuminoids, and with a slightly alkaline or a neutral reaction; solid nutrient substances are more favourable than liquid. Carbohydrates alone hinder or prevent the formation of mucilage and of the pigment. Under all these conditions the coccus-form remains unchanged, though the size of the individual micrococci varies. The formation of colonies is to a high degree dependent on the nutriment. In all cases in which there is a considerable separation of mucilage, especially, therefore, when there is abundance of albuminoids, chains of from 8–12 micrococci are produced; while in those cases where little or no mucilage is formed, or when supplied with carbohydrates only, or in certain saline solutions, the cocci are either isolated or are only associated in small numbers. In the former case it may be termed *Streptococcus ochroleucus*. The decompositions caused by the microbe vary according to the nutrient substance; if this is rich in albuminoids, the products are strongly alkaline; with carbohydrates or certain saline solutions they are, on the other hand, acid. For the production of the pigment abundance of nitrogen is required. A temperature of 36° C. is unfavourable to the vegetative development of the fungus; endogenous resting-spores are then produced, which germinate at 27°. Hard-boiled white of egg made slightly alkaline by dilute ammonia produced the most favourable results. The paper contains also a review of the other known yellow chromogenous microbes.

Nitrification.†—Sigg. A. Celli and F. Marino-Zuco state that in the course of analyses of water from the subsoil of Rome, amongst other

* Cohn's Beitr. z. Biol. d. Pflanzen, v. (1887) pp. 409–40 (1 pl.).
† Gazetta, xvii. pp. 99–103. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 858.

organisms a micrococcus of globular form (*Micrococcus cereus*) was discovered; this was found to be a very efficacious nitrifying agent. The authors quote experiments to prove that for the process of nitrification the presence of bacteria is not absolutely essential. It is further shown that among the organisms which liquefy nutritive gelatin *Bacillus saprogenus*, *B. fluidificans*, and *Micrococcus luteus*, when thrown on to sand in cultivating liquids, not only do not produce nitrates, but even destroy them completely; on the other hand, these same organisms, taken from potato-cultures, far from destroying the nitrates, are among the most active agents in producing them.

New (Indigogenous) Microbe.*—M. E. Alvarez reminds us that the indigo of commerce is obtained by the maceration of the leaves of *Indigofera*, which contains a glucoside which is soluble in water; the solution is allowed to be exposed to the air. He finds from the experiments he has made, that indigo is a fermentation-product, and that this fermentation is caused by a special microbe, which is rod-shaped and much resembles the microbes of pneumonia and rhinoscleroma. These latter also produce the indigo-fermentation, while the indigogenous bacterium has pathogenetic properties, causing either a temporary local inflammation, or death with congestions and fibrous exudations; the parts especially affected are the genito-urinary organs.

Certain Properties of Phosphorescent Bacteria.†—Prof. J. Forster, in conjunction with Dr. C. B. Tilanus, has made pure cultivations of bacteria which produce phosphorescence, and found that these micro-organisms have special properties.

By Koch's plate method those bacteria which under the Microscope appear as short thick rods, are easily cultivated if the gelatin contains 2–3 per cent. of salt. Bacteria obtained pure (bacilli) which do not liquefy gelatin, live and multiply in neutral or slightly alkaline nutritive media, even if very dilute, provided the necessary quantity of salt be present. In a gelatin made from fish they grew well with 6 per cent. of salt, while 7 per cent. decreased, and a still higher percentage altogether stopped their multiplication. On the other hand, an admixture with distilled water soon killed the bacilli, so that a weak salt solution was compulsory when a gelatin culture was placed on a cover-glass.

Pure cultivations of these bacteria, so long as atmospheric air is present, emit light in proportion to the size and age of the colonies, so that a plate-cultivation looks like the sky on a starry night. Plate or tube cultivations may be photographed in a perfectly dark room and a very clear picture obtained of the colonies. Although the light emitted even from large colonies is not strong, it is strong enough to suffice for a microspectrometric examination. Observed in the dark with the Zeiss-Abbe microspectrum ocular and 3 Leitz upper lens with a slit 1/3 mm., it was seen that a colony 1 mm. in diameter gave an apparently continuous spectrum between λ 0·58–0·43, the brightness of which was greatest between 0·48–0·51, and diminishing more quickly towards the red end than towards the violet. The spectrum of a weak galvanic incandescent light of about the same intensity was brightest at λ 0·60, while at 0·50 no light was perceptible, so that the slight extension of the bacterial spectrum towards red and violet is dependent on the feebleness of the light of the spectrum. Colour differences in the spectrum are not recognizable, and

* Comptes Rendus, cv. (1887) pp. 286–9.
† Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 337–40.

examined without the prism the phosphorescent colonies seem greenish, or even greenish blue.

Transmitted light is absorbed by the colonies, although absorption-bands are to be perceived. Examined with Zeiss objective A, microspectrophotometer, comparing prism, two Engelmann incandescent lamps, three large Groves, both spectra with a slit of $s = s_1 = 20$ (wherefore $1 = 0 \cdot 01$) were approximately equal, and gradations of light were found which on interposing the colony required for given wave-lengths the following decrease in the slit of the comparing prism:—

$$\lambda = 0 \cdot 66,\ 0 \cdot 63,\ 0 \cdot 60,\ 0 \cdot 57,\ 0 \cdot 54,\ 0 \cdot 51,\ 0 \cdot 48,\ 0 \cdot 45.$$
$$s_1 = 12 \cdot 1,\ 12 \cdot 4,\ 12 \cdot 0,\ 10 \cdot 8,\ 9 \cdot 9,\ 9 \cdot 4,\ 7 \cdot 7,\ 6 \cdot 3.$$

By multiplying the numbers found for s_1 by 5, the per cent. equivalent of the absorption is obtained.

These micro-organisms moreover show a vital phenomenon in which they differ from other phosphorescent bacteria. Pure cultivations in salinated gelatin, bouillon, potato, &c., emit light equally well at temperatures from 0°–20° C., but cease to give off light at from 32°. So far these properties agree approximately with the results of Pflüger, but if these bacilli be kept at 35°–37° C. for some hours, their vitality is so impaired that inoculation from colonies thus treated can no longer be reproduced in a nutritive medium previously found quite suitable. Yet they will grow almost equally well in a refrigerator, and even if the test-tube be surrounded by finely-powdered ice and then placed in the refrigerator, that is to say, at a temperature of 0° C.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

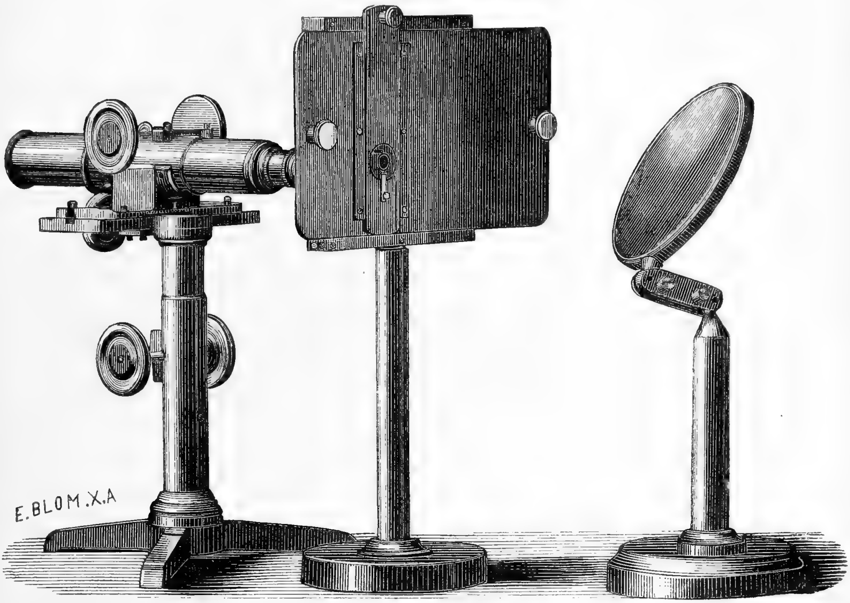
Schulze's Aquarium Microscope.—Prof. E. Schulze has designed and Messrs. Klönne and Müller have made the Microscope shown in fig. 235, for the observation of small aquatic organisms in an aquarium specially constructed for the purpose. There are three parts,—(1) the stand, the greater part of which is nickel-plated; (2) the aquarium; (3) the illuminating mirror.

The stand consists essentially of a Microscope-tube which is supported in a horizontal position upon a tripod in such a way that it can be moved in three different directions by rack-and-pinion. The column of the tripod carries a rack-and-pinion by which the tube is moved vertically. On the tube which carries the rack is a sliding-piece with a second rack for the horizontal movement from right to left; upon this slide the Microscope is fixed in a horizontal position and can be moved backwards and forwards in a tube provided with rack-and-pinion. There are therefore three movements, vertical, horizontal-lateral, and horizontal-sagittal, so that the organism observed can be followed by the tube as it moves upon the glass wall of the aquarium.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

The aquarium consists of a stand with a frame which carries the aquarium proper, 10 cm. in breadth and height, and 10 mm. in thickness; this may be replaced by others. The frame is made of brass lacquered black. The aquarium itself consists of a horseshoe-shaped piece of glass, both sides of which are closed by plates of cover-glass leaving the upper end open. It is thus possible to observe an organism upon either of the

Fig. 235.



two thin sides with an objective giving a linear amplification of 200–300. To screen off the superfluous light and the numerous reflections in the aquarium, the frame carries a diaphragm arrangement which can be applied on either side at pleasure. This consists of a sliding-plate which moves in two horizontal guides; it is divided into three parts, and has an oblong opening in one of the divisions. In this opening a thin plate slides and can be clamped at any point. In this plate again is a circular aperture, which can be closed to a greater or less extent by various diaphragms kept in position by a small spring.

If an animal is on the upper left-hand corner of the side turned towards the Microscope, the sliding-plate is first moved so that the vertical longitudinal opening lies in the left-hand third, the small plate is then set so that its opening lies in the upper third. If, on the other hand, the animal is on the right-hand side, the larger sliding-plate is moved so that the longitudinal opening lies on the right, and if the animal is towards the bottom, the small slide with its opening is moved downwards. The two sliding-plates are now so directed that light may be thrown by the mirror through the aquarium and upon the animal on the front side. The aperture can be further reduced by diaphragms.

The mirror is concave, 10 cm. in diameter, and fixed upon its stand with a ball-and-socket joint so that it can be adjusted in any position.

Giles's Army Medical Microscope.—Mr. G. M. Giles, Surgeon-Naturalist, Indian Marine Survey, writes, that "to the military surgeon, or explorer, who has to carry a Microscope with him, bulk and weight are considerations of the first importance. Even in peace time the former is so often on the move, that he early learns to dispense, as far as possible, with bulky and heavy articles." Hence he was "anxious to devise an instrument which while it should pack into a moderate-sized box, should not be open to the objections of some of the existing forms, and in fact should be applicable to all the work of the military surgeon in station as well as in camp life." This is shown in fig. 236.

Fig. 236.

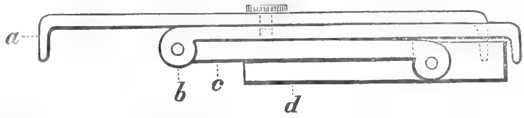
"The great obstacle in the way of making a sufficiently portable stand is that, in all previous patterns, the stage is permanently fixed to the body, and so has to be limited in size in order not to unduly increase the cross measurement of the box. This difficulty has been met by making the stage and foot in one piece, arranged so as to fold up flat, for packing (fig. 237), the body and pillar being keyed on to the stage and fixed in position by the arm carrying the mirror being used as a nut.

When set up, the instrument is about 9 in. high, and the stage measures 2·5 in. by 2·2 in., and is quite adequate to all ordinary pathological work. When folded up, it packs, including the centering substage described below, into a strong box 5·8 in. by 3·2 in. by 2·75 in. outside measurement. By making the box a little longer (7 inches) an extra objective, double nose-piece, and polariscope can be carried in addition, the last-mentioned piece of apparatus being a special desideratum to the geological explorer.

Every microscopist knows how much definition is improved by the use of the German form of diaphragm, the aperture of which is level with the stage, and does not markedly exceed the field of the objective. In a portable instrument, these can hardly be used except in a centering substage, of which I have devised a very simple and inexpensive form for the purposes of this instrument. It consists of a short, stout brass tube, screwing into the opening in the stage. The tube carrying the diaphragms, polarizer, condenser, &c., is provided with a double collar, and is supported within the larger tube by means of three screws. One of these has a thread only at its point where it screws into the inner tube, its shaft working freely in a hole in the outer. Between the two tubes it pierces a small piece of solid

rubber which acts as a spring. The other two screws are provided with milled heads, and work in holes tapped in the outer tube, their points alone being free from thread, and made to fit exactly into the slot of the double

FIG. 237.

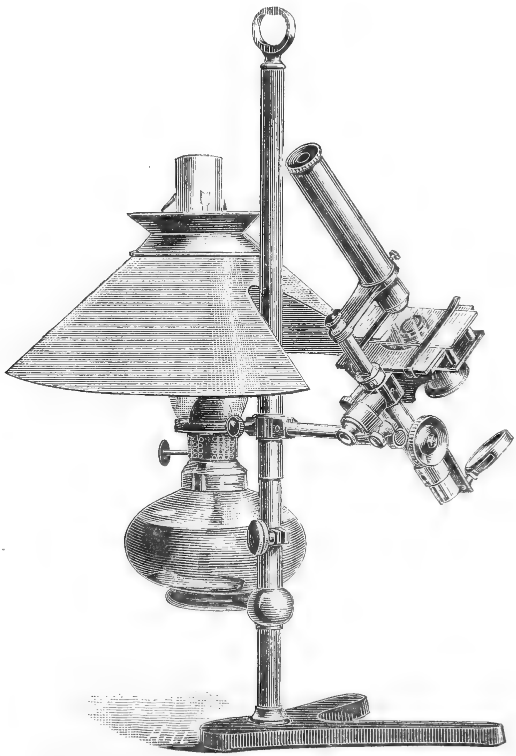


Elevation of stage and foot when folded. *a*, transverse limb of foot; *b*, antero-posterior ditto; *c*, pillar; *d*, stage.

collar, which they press against the resistance of the rubber spring. The second objective is carried within the tube of the Microscope, screwing for packing on to the upper side of an adapter. This also serves to carry the analyser when the polariscope is in use."

Nelson's Portable Microscope.—Mr. E. M. Nelson exhibited at the November meeting of the Society a new portable Microscope (figs. 238 and 239), made by Messrs. Powell & Lealand from his drawings.

FIG. 238.



The instrument is adapted for three different modes of use, viz.:—(1) As a small table Microscope for home use (a very useful adjunct to a large instrument); (2) as a portable Microscope for the exhibition of objects at

Societies, &c. (fig. 238); (3) as a field Microscope and class demonstration instrument (fig. 239).

The instrument has two objectives, a 4/10 in. and a 1 in., which, with two eye-pieces, give the following powers:—35, 70, 100, 200. The 4/10 is of 0·65 N.A. The highest power, therefore, is equivalent to a 1/2 in. of

Fig. 239.

80° with a C eye-piece, or a 1/4 of 80° with an A eye-piece, on an ordinary full-sized English Microscope. The lowest eye-piece is on the Abbe compensating principle.

In the mechanical portion of the instrument are several new features. The design of the Microscope is that which is generally known as the bar movement. It has a rack-and-pinion coarse-adjustment, and no fine-adjustment, thereby following the dictum of the great master (the late Hugh Powell), who said, "In an elementary Microscope a good coarse-adjustment without any fine is better than one with a second-rate fine and no coarse-adjustment." The truth of this statement is daily verified in the shaky condition of the fine-adjustments of students' Microscopes which are fitted with a direct-acting screw fine-adjustment and a sliding-tube coarse-adjustment. The body of the Microscope is 3 inches long. The stage is of Mr. Nelson's horseshoe pattern, and the spring clips are those of Hugh Powell. Although strongly opposed to all kinds of clips, Mr. Nelson found they were necessary in this instance to permit of the complete inversion of the instrument. The great difference between these clips and those of the usual form is that these being fixed underneath the stage, allow a smoothness of action to the slip which is totally foreign to the others.

To the underneath side of the stage is fixed the substage which carries an achromatic condenser, focusing by means of a sliding-tube.

The stage and substage rotate on an axis, so that they may be turned into the plane of the trunk for packing.

There is a plane mirror mounted on a crank arm. The foot is circular, rests on three points, and has an upright rod capable of extension like a

bull's-eye stand. On the top of the upright there is a short horizontal arm, to which the Microscope is attached.

For portable and exhibition purposes the instrument fits on to the Microscope lamp-stand, the same apparatus being used to attach it as in the first case (fig. 238).

When the Microscope is required for field or class purposes this attaching piece is taken off, and is replaced by a handle (fig. 239). The handle and the attaching piece are so arranged that the Microscope cannot shake loose or twist off, or get off the square.

When the instrument is used in the field, the mirror is swung to one side, and the condenser is pointed to the sky.

Woodhead's Microscope with large Stage.—This Microscope, devised by Dr. Woodhead and made by Mr. H. Crouch, has a stage of unusually large size, 11¾ by 9¾ in., for the examination of sections through entire organs.

Selenka's Electric Projection-Lamp for Microscopic Purposes.*—Prof. E. Selenka describes a Projection-Microscope constructed for him by Herren Reiniger, Gebbert, and Schall, of Erlangen, "which, by its practical and convenient construction, fulfils its purpose in a remarkable manner." He describes the apparatus fully "in the expectation that it will soon be more largely used; for thousands of microscopic objects can in this way be used without difficulty for demonstration, and although there is no question that the ordinary diagrams and lithographs have done, and will do good service, yet the impression made by the exhibition of the object itself is much more vivid and permanent than that produced by a representation."

To show what objects are of value for demonstration in zoological lectures, for a large circle of students, the author states that at a distance of 5 metres from the screen the contractile vacuoles and the so-called streaming of granules in living *Amœbæ* are clearly visible, as are also the ciliary movements and ingestion of food by Infusoria. "In stained calcareous sponges the flagellated chambers and spicules may be shown, as may also the cellular structure of the arms of hydroid polyps, and the entire sexual apparatus in the proglottides of tape-worms. *Trichinæ*, *Echinorhynchi*, Trematodes, worm-larvæ, small Annelids mounted in balsam, Rotatoria, and Copepoda in the living condition give incomparable images, as also the larvæ of Echinoderms and Molluscs. Sections of the embryos of vertebrates stained with carmine or hæmatoxylin make excellent objects to show the development of the vertebræ, heart, nerve-fibres, sense-organs, amnion, allantois, and urogenital system. I can show without any difficulty the cleavage of the egg, gastrulation, rudiments of the cœlom, and even the formation of yolk-rays in the segmenting ovum, and the filamentar loops in the dividing nucleus. Charming images are given by the membrane between the digits of the foot of the living frog or the gills of the *Salamander* larva, the tracheæ of the flea or the louse, &c. And how quickly and simply is the demonstration effected! In those lectures in which I intend to project microscopic objects, the discourse proceeds without interruption, and the last five to ten minutes are used for the demonstration. At a given signal the projection-lamp is put into action, and then all that is required is the complete darkening of the auditorium. This is rapidly and easily effected by lowering canvas blinds covered on both sides with a thick coating of oil-paint of any desired colour. The blinds are raised and lowered by means of a winch; the demonstration is made without any assistance.

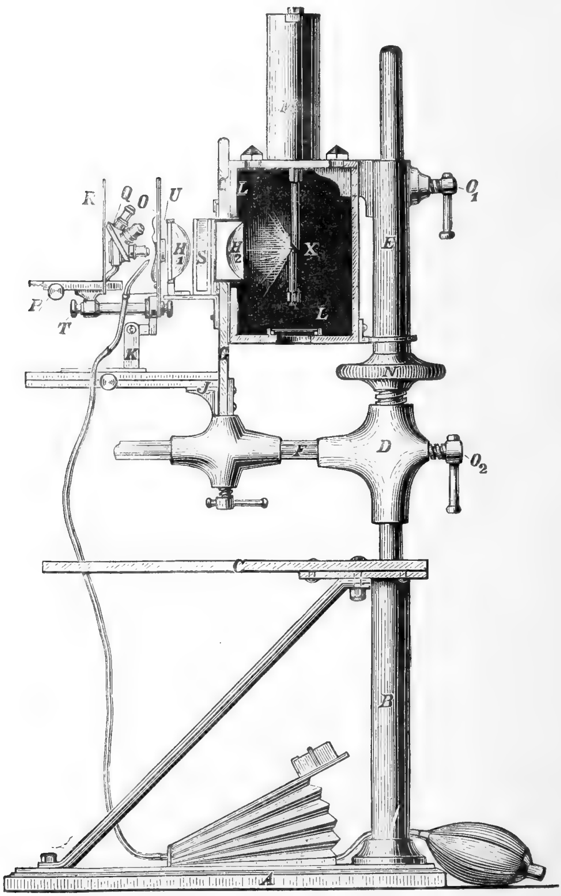
The light is obtained from a dynamo machine driven by an engine of

* SB. Physikal.-Med. Soc. Erlangen, 1887, Heft 19, 8 pp. (1 fig.).

two horse-power, and supplying an arc light of about 1200 candle-power. This is sufficient for a linear amplification of 1000; but for oil-immersion or for high-power dry systems an illuminator is required. An achromatic condenser has accordingly been designed by Prof. Abbe, as the ordinary chromatic Abbe condenser cannot be used for the purpose. The brightness of the image is increased to an extraordinary extent by the achromatic Abbe condenser, and, so far as I can estimate, is nearly equal to that which, without this system of lenses, would only be attained by an arc light of 2500 candle-power. Since the condenser is only used with the higher powers, it requires a simple adjustment by which it can be removed. The brightness of the image can, of course, be considerably increased by using a more powerful source of light.

The construction of the lamp (fig. 240) has been left entirely to the

Fig. 240.



mechanician. A is a rectangular plate of cast iron into which the cylindrical iron rod B is set, and fixed by two iron stays. At the height of the table is a shelf C for the objects not in use. Above the shelf are the two iron

tube-pieces which slide upon the rod B and are clamped by the screws O_1 and O_2; the lower and shorter of these tubes D carries on the horizontal ribbed arm F, the plate G with the condensers H_1 and H_2, and also the plate J with the Microscope K. To the upper and longer tube E is fixed the light-chamber L with the arc-lamp M screwed to its upper side.

The light used is that known as the Piette-Krizik lamp which, on account of its accuracy of regulation, has been very largely used, and for this very reason has been better tested than many other systems, and which, in spite of its excellent construction, is moderate in price. Since, however, with the best regulated lamps the point of light after long use is invariably shifted slightly upwards or downwards, the piece which carries the lamp and the light-chamber is made to slide up and down the fixed part which supports the condensers and the Microscope, so as to bring the point of light back into the axis of the condensers. This movement is effected by means of a nut N which works between the parts D and E upon the screw-thread of D, so as to raise or lower the light-chamber L and the lamp M, and bring the point of light X to any desired height. A rotation of E with the light-chamber is rendered impossible by bringing the plate G close against the front side of L and making it fit in grooves upon the front of the light-chamber, so that the two parts can only move upon one another in a vertical direction and keep the source of light completely inclosed.

The light-chamber is made of strong oak, and to the top is screwed the lamp from which the two iron rods which carry the carbons project into the chamber. In the top are also, besides the aperture for the carbon-holders, several ventilating holes to carry off the hot air; these holes are covered with tin caps to screen the light. The left side of the chamber is entirely closed, while the right side is provided with a door to allow the insertion of new carbons, &c. In the centre of the door is a circular hole closed with dark glass through which to observe the glowing carbon points. At the bottom of the chamber is a circular opening through which the shelf for the objects is illuminated, and which serves for ventilation; above the opening is a dark glass to moderate the light and to catch the ash which falls from the carbons.

The front side of the chamber has an aperture into which the condenser-holder projects. This aperture is made large enough to allow free play for the chamber; the source of light being brought into the axis of the condensers, as was said above, by a motion of the chamber. In the axis of the lenses H_1 and H_2, is the Microscope K, supported on the plate J which is attached to G.

For the lenses I use the ordinary horseshoe stand with the following alterations: (1) the upper piece for rotating the Microscope is unscrewed from the foot, turned through 180°, and fixed again to the foot so that the stage is not over the horseshoe, but projects behind it; the horizontal Microscope can then be brought as near as is required to the large condensing lens H_1, which with low powers is necessary to secure a colourless image. (2) Instead of the small thick stage, a large plate O with diaphragm U and two clips is used; (3) in place of the tube moved with rack and pinion, there is an arm P, moved in the same way and carrying the nose-piece Q, which allows a rapid change of objectives. A metallic screen R, of 15 cm. diameter, serves to arrest the rays which pass beside the objective; this is placed immediately behind the nose-piece.

With high powers the object must be brought near to the focus of the condensers, while with low powers it must be moved beyond the focus and

brought nearer to the condenser. This movement is effected by a sliding motion of the stand K between two wooden guides, by means of rackwork.

Between the two condensing lenses it is necessary to insert a glass trough S, with plane sides filled with concentrated alum solution, to prevent the over-heating of the object. Thick or dark-coloured objects are very easily over-heated; an energetic and invariably sufficient means of cooling is obtained by a current of air directed upon the surface of the object or upon the cover-glass. Compressed air is obtained from a loaded india-rubber bag (above A). The delivery tube is of brass, with an aperture of 1/2–1 mm., and is fixed to the stand at an angle of 45° on the under side of the objective; the distance of the aperture from the cover-glass being about 1 to $1\frac{1}{2}$ cm.

The coarse-adjustment is effected by the rackwork on P, the fine-adjustment by the micrometer-screw T. The objects are held by one or two of the usual clips against the vertical stage.

The nearer the lamp is to the white paper screen, the brighter will be the images, but the less the amplification. After several trials a distance of 5 metres between the object and the screen has proved the most convenient. By using a stronger source of light, this distance may easily be increased to 6–10 metres.

To bring the projected image as near as possible to my audience, I place the electric lamp in the middle of the amphitheatre, and the screen in front of the first row of seats, an open passage being left between the lamp and screen. There is no objection to the image being seen obliquely foreshortened by those of the audience who are at the sides; it scarcely loses in clearness thereby.

White paper does not give nearly such bright and clear images as a plaster surface. This is made by bending an iron band into a circular or rectangular form, making a network of wire across it, and placing the whole upon a glass plate which has been rubbed over with powdered talc. Alabaster plaster is poured upon the network, and when it is cool the whole mass is lifted off. The projection plate should have a diameter of 1·2 to 2 metres. Trials with transparent screens, such as oil paper, tracing paper, or ground glass plates gave unsatisfactory results.

After numerous experiments it has been found that the finest images are given by those objectives which have been made for a long tube, especially the so-called photographic objectives. It is not advisable to make use of an eye-piece for projection purposes.

To cut off all extraneous light, it is a good plan to place over the condensing lens H_1 and the alum trough S, a light cardboard case which is prolonged into a cardboard tube towards the stage of the Microscope in the direction of the beam of light.

Finally it may be mentioned that it is possible to use a horizontal stage. The beam of light is then reflected upwards by the ordinary plane mirror, and again deflected into a horizontal direction by a prism of flint glass, which rests against the upper nose-piece aperture.

Of the objectives which I have employed, the following give the best defined images:—Hartnack, objectives 1 and 2; Seibert, 1 in., 1/2 in., and 1/4 in. photographic objectives; Winkel, objective 7; as well as water- and oil-immersion objectives of various makers.

Absolutely colourless images of extraordinary clearness are given by the combination of the new Zeiss apochromatic objectives with the corresponding 'projection-eye-pieces.' Though this combination is unrivalled for photographic purposes, it is not convenient for demonstration, since the image is too faint and of too limited dimensions."

The whole apparatus is supplied in this country by Mr. K. Schall, of

55, Wigmore Street, W. It was exhibited at the meeting of the Medical Congress at Dublin in August, where it was reported * to have "proved itself infinitely superior to the oxyhydrogen limelight as a means of class demonstration."

At the Hygienic Congress in Vienna, Prof. S. Stricker also gave demonstrations with the electric Microscope, which, it is claimed,† conclusively prove the value of this new method of medical teaching. Among other things, Prof. Stricker exhibited photographs by transmitted light, with 1400 linear amplification, and a section through the spinal marrow of an adult man, in which the ramifications and crossings of the nerves could be most clearly seen. A demonstration was also made with incident light and an amplification of 72,000 times, the object being the exposed pulsating heart of a turtle. "The whole action of the heart could be followed in the most surprising manner, the flow of blood to the great aorta could be observed, and an insight obtained into the inner life to an extent which is seldom realized by experienced students of hygiene."

Leach's Lantern Microscope.‡—At the Soirée of the Manchester Microscopical Society, on the 29th January, 1887, Mr. W. Leach exhibited a Lantern Microscope, attached to a photographic camera, the bellows body of which opened out to thirty-six inches. With a 4/10 in. objective, images were shown upon the screen magnified eighty diameters, and "were seen well defined, brilliantly and equally lighted, without covering being placed over the camera, notwithstanding the gaslights overhead and all around the room. The field was noted for being as even as a sheet of writing-paper. When the lantern door was opened much astonishment was expressed, when it was seen that all this illumination was obtained from a small paraffin lamp burning with a single half-inch wick."

The author in his paper describes his experiments and results as follows :—

"It is some eight or ten years since I felt dissatisfied with the results which I was then able to obtain with the ordinary lantern arrangements for projecting microscopic objects upon the screen, and began to make experiments with the aim of getting more successful illumination. The amount of light transmitted through the bi-lens lantern condenser being in the inverse ratio of the square of the distance between it and the luminant, I tried to shorten the space by the well-known device, first introduced by the Rev. W. T. Kingsley about 1855, of adding a third lens to the other two, and thus shortening the compound focus. But this I soon found was, without further addition, of no use whatever, as the cone of rays at its apex was so large, or the light passed through it at so great an angle, that it was impossible to transmit it through both the object and the objective. Thus the beam of light, however strong it might be at the focus of the condenser, did not reach the screen, and therefore served no purpose except that of boiling the object in the balsam used in mounting it.

I next placed another lens in the cone of rays a little beyond the focus, and hoped by this means to so lessen its diameter as to make it capable of transmission. This was a sort of substage arrangement, and was found to be a great improvement when the lens was of the right focus for the objective, and was situated at the right distance from both it and the object. To be able to thus place it at the right distance from both, meant having a substage lens for all objectives differing widely in power, the focus of each being such as the power and construction of the others might require.

* Brit. Med. Journ., 1887, Aug. 27, p. 470.
† Central-Ztg. f. Opt. u. Mech., viii. (1887) p. 250.
‡ Brit. Journ. of Phot., xxxiv. (1887) pp. 153-4.

Rack-and-pinion movement was also found to be necessary, so that the rays might be properly focused on either side of the object. The lenses used should be large enough to take in the whole cone of the principal condenser, and for the higher powers it is requisite to combine two or three of them together. The highest as well as the lowest powers may thus be made useful for lantern projections. Mr. Kingsley stated in his paper upon this subject at the time I have just named that he could transmit as much light through the higher as through any of the lower powers, and gave diagrams of the arrangement which he made use of.

So much for the past; now we come to the present. The objectives which I shall use this evening are 2 in., 1 in., and 4/10 in. The 2 in. requires the substage lens to be a little over 2 in. focus, $1\frac{3}{8}$ in. diameter, plano-convex. A similar kind of lens, $1\frac{3}{4}$ in. focus, proves in my hands to be a good all-round condenser for all powers from $1\frac{1}{2}$ in. up to 4/10 in. objectives. By liberal use of the rack-and-pinion and of the concave lens to be presently described, this substage lens gives the most brilliant results throughout this wide range of powers. The 1/4 in. objective, when it is desirable to use it for photographic purposes, requires two lenses; the back one to be $2\frac{1}{2}$ in. focus and $1\frac{3}{8}$ in. diameter, and the front one $1\frac{1}{4}$ in. focus and 1 in. diameter, both plano-convex. This also makes a good condenser for the 4/10 in. objective. All the lenses must have the curved surfaces turned towards the lantern. The luminant goes to within $1\frac{3}{4}$ in. of the back lens of the principal condenser with the 2 in., and to within 2 in. with the other two objectives. I have tried it closer than this, by using a back lens of shorter focus, without advantage—in fact, considerably otherwise. If a flint concave lens is placed in the cone of rays about one or two inches before the really active ones begin to cross, the light is much improved. The concave which I use is about 6 in. focus and $1\frac{3}{4}$ in. diameter. It is so placed in the tube which carries the other substage lenses that its distance from the principal condenser can be altered so as to modify the length of the cone of rays to adapt the focus of the other lenses to the objective when they do not exactly meet its requirements. The concave lens was, I believe, first introduced into the lantern cone of rays by J. T. Taylor in 1866, for the purpose of parallelizing them, but I do not use it for any such purpose in this lantern Microscope. In my lantern polariscope I imitate Taylor in the use of the concave, but here the purpose served is quite a different one. My lantern condenser is $3\frac{3}{4}$ in. diameter, with a plano-convex $3\frac{1}{2}$ in. diameter and 7 in. focus, mounted upon the back of the tube which carries the other lenses.

In lantern Microscope projection three things are essential. The first is brilliant illumination, the second large amplification, and the third clear display of detail. But brilliant illumination does not mean a dazzling display of light upon a large white screen, showing a dark, patchy outline of an object, without detail. Objects shown in this way are far inferior to an enlarged woodcut. The light must be made to enter the object so as to bring its structure out to the eye of the onlooker. But no amount of light will do this if its dimensions are too small for the crystalline lens to form an image of it upon the retina. With high-power objectives the light must, in the nature of things, be greatly subdued. Still, a large image, moderately bnt properly lighted, can be far better seen than a small one many times as bright. An object may in fact be too bright to be seen. If rays of great angle are too powerfully converged upon it the image becomes as bright as that part of the screen which represents nothing but bare glass. It is in this case just like an over-exposed photograph, flat and without contrast. The image may, therefore, be too bright for the screen, just as it

may be too black for it, and what we have to aim at is that mean which will show the detail in one without making the other too glaring.

Having made our arrangements according to what is here advanced, we ought to be able to show the various minute organs of insects and the details of vegetable and animal tissue. I have shown very finely the blowfly's tongue over sixteen feet long, and the male flea with its outstretched legs twelve feet long. Sections of spine of *Echinus* may be magnified to seven or twelve feet diameter, and sections of a rat's tail eight feet diameter. Mites in cheese with such powers become large as guinea-pigs, and *Volvox globator* gracefully rolling over a sixteen-feet screen are larger than tennis-balls. The cornea of the *Dytiscus* is a most wonderful object when shown eight to ten feet in diameter.

When I say that such things can be shown in such enormous sizes, you must not suppose that the display will be like an outline map, black and skeleton-like in appearance upon a white ground. Instead of that the small capillary blood-vessels in anatomical sections, the various appendages of the feet of insects, the hairs of plants, the rings of insect tracheæ, the eyes of insects with the light gleaming through each facet of the cornea, with other equally minute details, can be displayed to an audience with very great satisfaction. That, you must admit, far surpasses anything ever achieved by the old lantern Microscope, and we boldly challenge any admirer of the old method to show that he is not now left as far behind by the new one as the old stage-coach is left behind by the railway train.

I think I ought to say that my lantern Microscope has been made by myself. All its details have been worked out by myself. I have, of course, utilized any old photographic lens mount, or old Microscope fittings which I could get to work up into my arrangement, so as to save mechanical labour. It fits, as you will see, into the ordinary lantern front. The alum trough goes into the place which holds the slider when the lantern is used for ordinary pictures. The stage is one of Dancer's old lantern Microscope stages, but is modified so as to hold and enable me to change the substage condensers, which can be done more easily and with less loss of time through mine than it can be done through any other arrangement. The compactness of the instrument is also something worth considering.

Since the foregoing pages were written I have fitted up a 1-inch objective which is very satisfactory. It transmits a large beam of light, and gives a flat field of great size, the central and marginal definition being fairly good at the same time. As a rule the best ordinary objectives give no definition beyond a small circle in the middle of the field."

Newton's Electric Polarizing Projection-Microscope.—This instrument, constructed for the Science and Art Department, South Kensington, by Messrs. Newton and Co., and exhibited at the Conversazione in November, is of similar construction (with only necessary modifications) to the oxyhydrogen projection Microscope which was described by Mr. L. Wright in this Journal, 1885, p. 196. It will give good results with immersion lenses up to 6000 diameters and upwards; the magnification possible depending chiefly upon the *opacity* of detail necessary for a large screen image.

In addition to the usual polarizing effects it is fitted with lenses for exhibiting the brushes and coloured fringes in crystals, and also for use with the oxyhydrogen jet.

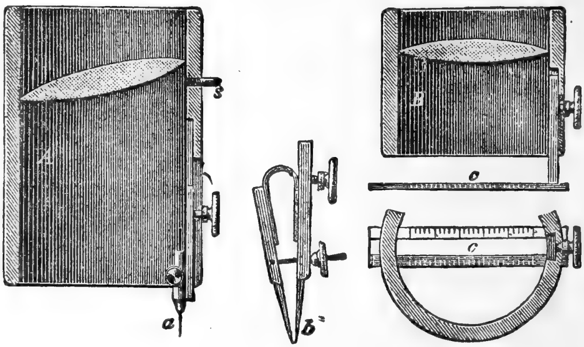
Lehrke's Lens-holder.*—Herr J. Lehrke's arrangement (fig. 241) consists of a cylindrical metal- or horn-mounted lens, 2–4 cm. long, and

* Zeitschr. f. Instrumentenk., vii. (1887) pp. 218–9 (4 figs.).

2–3 cm. in diameter, and magnifying from 1–2 times, whose side is provided with a contrivance for holding a copying needle, a protractor, &c.

While hitherto the architect, in using millimetre paper, must hold separately in his hands a magnifying glass and needle, while the engraver holds the engraving tool inclined in one hand and the magnifying glass in the other, or must work under a large lens standing on three feet, it is now possible, by a firm connection between the lens and needle or other

FIG. 241.



instrument, to draw directly with one hand, and under the lens. One of these lenses is shown in section at A, the glass is set obliquely, the needle *a* being in the focus. The stud *s*, projecting a little near the glass, is for the purpose of preventing the instrument from leaving the position coinciding with the plane of the drawing. For architects and engineers is provided a small compass *b* (about 2 cm.), for laying off parallel divisions, for making smaller scales, and the like. In these cases it is substituted for the needle. In like manner, for reading parallel divisions, for estimating areas, or revising maps, a finely divided, prismatic, ivory rule *c* can be placed under the glass B. In this case the plane of the lens must be perpendicular to the axis of the tube. For draughtsmen a parallel drawing-pen, something like *b*, is used, which gives several lines at once, perfectly parallel and close together; or a drawing-pen with which the smallest names, such as boundary stones and figures, can be made neatly and exactly. Thus a whole series of instruments can be used with the lens. For instance, a naturalist can use with it a knife or other instrument.

HENNEGUY.—**Sur un nouveau Microscope de voyage construit par Dumaige.** (On a new travelling Microscope made by Dumaige.) *CR. Soc. Biol.*, IV. (1887) No. 7.

Linnæus's Microscope.

[At the Pittsburg meeting of the American Society of Microscopists, "a very curious Microscope, once the property of Linnæus, was described by C. C. Mellor," President of the Iron City Microscopical Society.]

Microscope, VII. (1887) p. 271.

(2) Eye-pieces and Objectives.

Thickness of cover-glass for which unadjustable objectives are corrected.*—Prof. S. H. Gage communicated to the Pittsburg Meeting of the American Society of Microscopists the following paper:—" As the thick-

* Microscope, vii. (1887) pp. 292–3.

ness of the cover-glass as well as the tube-length has an important influence on the perfection of the microscopic image, and as almost all objects for microscopic examination are covered, the objective must be adjustable to compensate for the various thicknesses of cover-glasses used, or some uniform thickness of cover-glass must be selected, for which the optician corrects or adjusts the objective once for all. The thickness for which such unadjustable objectives are adjusted varies with the different opticians, as shown in the table below. The information in the table was obtained by direct inquiry as for the information concerning 'tube-length' hereinafter mentioned.' *

TABLE *showing the Thickness of Cover-glass for which unadjustable objectives are corrected by various Opticians.*

0·25	mm.	J. Green, Brooklyn. J. Grunow, New York. Powell & Lealand, London. H. R. Spencer & Co., Geneva, New York. W. Wales, New York.
0·18	mm.	Klönne & Müller, Berlin.
0·17	„	E. Leitz, Wetzlar (when tube 160–170 mm.)
0·16–25	„	Ross & Co., London.
0·16	„	Bausch & Lomb Optical Co., Rochester.
0·15–20	„	(16 mm. apochromatic oil-immersions), C. Zeiss, Jena.
0·15–18	„	C. Reichert, Vienna.
0·15	„	Gundlach Optical Co., Rochester. W. & H. Seibert, Wetzlar. R. & J. Beck, London.
0·12–17	„	J. Zentmayer, Philadelphia.
0·10-125	„	Nachet et Fils, Paris. Bezu, Hausser et Cie, Paris.
0·1	„	Swift & Son, London.

A uniform thickness of cover-glass for unadjustable objectives seems also desirable; then by the use of some cover-glass measure, like the one made by Zeiss, the microscopist could select covers of the proper thickness to be used for the specimens to be studied with unadjustable objectives."

Objectives.

["An optical firm offers for sale 'homogenerous' immersion objectives."]

Queen's Micr. Bull., IV. (1887) p. 39.

PELLETAN, J.—**Les Objectifs.** (Objectives.)

Journ. de Micr+gr., XI. (1887) pp. 446–8, 476–81 (in part).

ROSS, W. A.—**New Optical Substance for Objectives of Microscopes, &c.**

["A transparent substance (it is not glass, for no alkali is employed in its manufacture)" having "a hardness and specific gravity equal to that of emerald, whilst its refractive index is obviously very high." And reply by F. H. Wenham that he has "seceded from the ranks of the 'Diatomaniacs,' and ceased to take any interest in dots and striæ, and it is not probable that I shall ever again work at the Microscope or its appliances."]

Engl. Mech., XLVI. (1887) pp. 278 and 301.

SCHULZE, A.—**On Abbe's Apochromatic Micro-objectives and Compensating Eye-pieces, made of the new optical glasses in the works of Dr. Carl Zeiss in Jena, with some general remarks on object-glasses.**

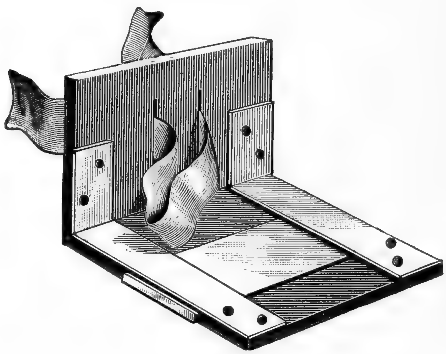
Proc. Phil. Soc. Glasgow, XVIII. (1887) pp. 28–40.

* Cf. *infra*, p. 1029.

(3) Illuminating and other Apparatus.

Borden's Electrical Constant-temperature Apparatus.*—Referring to this apparatus described *ante*, p. 810, Dr. W. C. Borden writes that, owing to some mistake, the latter part of the description of the regulating thermometer was not clear. After describing the regulating thermometer made from a glass tube and small vial, and filled with 95 per cent. alcohol and mercury, which will keep the temperature within one-half a degree, it was intended to say that a simpler one, which will keep the temperature within two degrees, can be made by simply blowing a bulb on a glass tube and filling the bulb and a portion of the tube with mercury alone.

Fig. 242.



Frog-holder.† — Mr. W. Fearnley describes the frog-holder, fig. 242, which he recommends, as enabling the frog to be placed "in a comfortable position."

It consists of a piece of cardboard 13 × 8 cm., bent at right angles across its larger axis, the angle being maintained by two copper rectangular straps riveted to the cardboard. A rectangular piece is cut out of the middle of the horizontal half and a glass slip put in between the cardboard and the copper straps. Two slits in the upright half, 1 cm. apart, admit a length (12 cm.) of broad tape. "The frog sits quietly for half an hour at a time upon this contrivance with or without whiffs of chloroform."

Macer's Insect-holder.—This (fig. 243) has been designed by Mr. R. Macer for showing the head, eyes, proboscis, &c., of insects in their living state, with their mode of taking food.

Fig. 243.

The cones are made of pieces of writing-paper gummed together, and left to dry. Some small discs about 5/16 in. in diameter are cut, and a hole made in the centre with a No. 3 or 4 saddler's punch. These are blacked and gummed on the cone near to the apex, and, when dry, the apex is cut off level with the disc. With a small stiletto the hole should be made round and smooth. It is necessary to make the holes of different sizes, viz. Nos. 11, 12, 13, 14, 15, and 16 B.W. gauge, to suit the various-sized insects. The disc on the top of the cone is to lay a piece of honey on, to tempt the insect to extend its proboscis in order to show the act of sucking.

For catching the fly, glass tubes, $2\frac{1}{2}$ in. long by 1/2 in. in diameter, with corks to fit, are useful, having a V groove cut in the cork in order to let air into the tube. At the other end of the tube is placed a small plug of cotton-wool. To pass the fly into the cone, hold the tube upright, shake the fly to the bottom (the wool being at the bottom), draw the cork, and place the base of the cone on the tube; then hold the apex of the cone to a bright light, and gently push the plug of wool up

* Amer. Mon. Micr. Journ., viii. (1887) p. 175.
† 'A Course of Elementary Practical Histology,' 1887, pp. 194–5 (1 fig.).

the tube with a pencil, and the fly will soon show its head through the hole in the disc. The tube is then taken away, and the wool plugged up in the cone to keep the fly in its place. A pair of stage forceps, with the ends made hollow like a pair of gasfitter's pliers, can be used to hold the cone.

Mr. Macer showed a living house-fly with this apparatus, at the November Conversazione, in a very effective manner.

(4) Photomicrography.

Nelson and Curties's Photomicrographic Camera.—At the November meeting of the Society Mr. E. M. Nelson read the following description of his photomicrographic camera (fig. 244) *:—“ Mr. C. L. Curties and myself have designed this camera in the hope of combining efficiency with simplicity. The points in its construction are as follows :—A board on indiarubber feet of sufficient length to take lamp, Microscope, and camera when fully extended. The usual chocks to hold the Microscope feet, and the fine-adjustment focusing-rod on the right-hand side of the board. The camera made of two square † tubes of cardboard sliding one inside the other. Upright wooden ends to hold the cardboard tubes; these slide in grooves in the base board, and are fixed by clamping-screws. The front board has a brass nozzle to fit into the light-excluding cap on the Microscope. The back board is grooved to receive the focusing-glass and the double back. The light-excluding cap is made of cardboard covered with leather, which is as efficient, and not so heavy, as the ordinary brass ones. The double backs are of iron; they are about one-sixth of the cost, and far smoother in their action, than mahogany ones. There is a fitting to hold diaphragms in the back.

The method of working is as follows :—The Microscope, inclined to a horizontal position, is placed in the chocks, the camera closed up, and slid back as far as it will go to the other end of the board. There will now be plenty of room between the camera and the Microscope for the eye to be conveniently placed to the eye-piece. The lamp, condenser, &c., are now centered in the usual manner, and a critical image of the object received by an ordinary eye-piece. When all the necessary adjustments are completed, the ordinary eye-piece is removed, and a projection eye-piece substituted for it. The camera, still closed, is now slid up to the Microscope, leaving sufficient distance between them to allow the hand to focus the eye-lens of the eye-piece. Next let a piece of paper be held up in the position the back will occupy when the photograph is being taken, and the diaphragm of the eye-piece focused, by means of the eye-lens, sharply upon it. The camera is now slid up to the Microscope, and the nozzle inserted in the light-excluding cap. The camera is now extended to the required distance, and the object focused on the plate in the usual manner.

The following are a few hints in the use of the above camera :—It is not advisable to push magnifying power more than ten times the initial power of the objective. To this end the camera has been designed for use with Prof. Abbe's lower-power projection eye-pieces, as he recommends the lower-power eye-pieces in preference to the higher when sufficient camera length can be obtained.

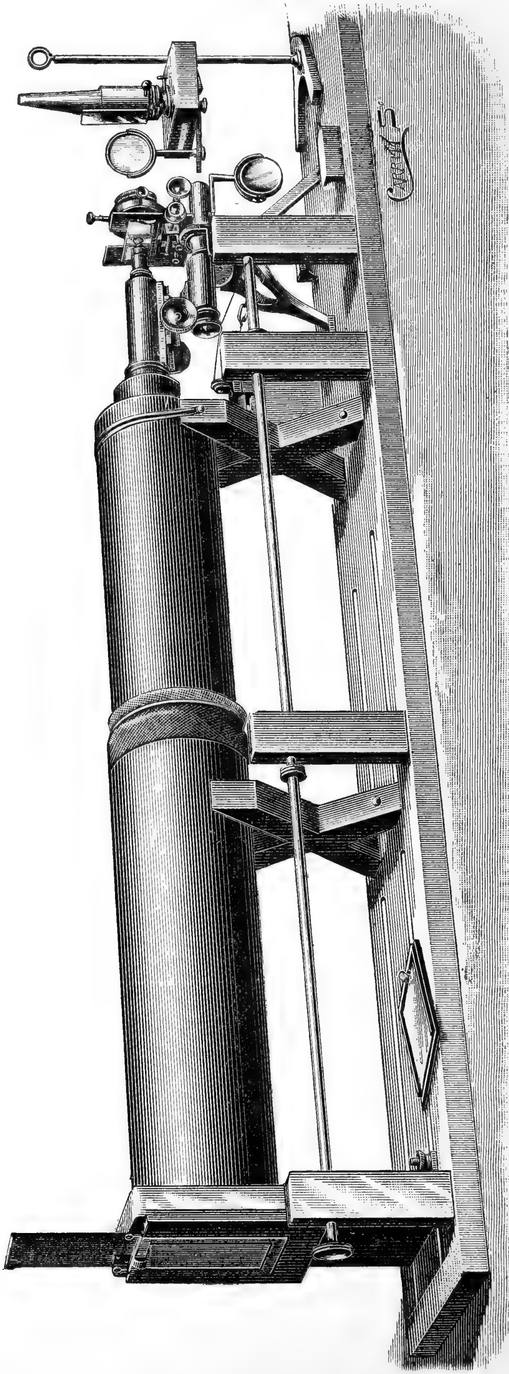
A plain glass screen is recommended in place of the usual ground glass.

The best focusing-lens is an aplanatic lens of six power by Zeiss (Catalogue No. 127).

* Described *ante*, p. 661.

† As shown in the fig. these are round; they were subsequently made square on the suggestion of Mr. J. Mayall, junr., as being more serviceable in that form.

FIG. 244.

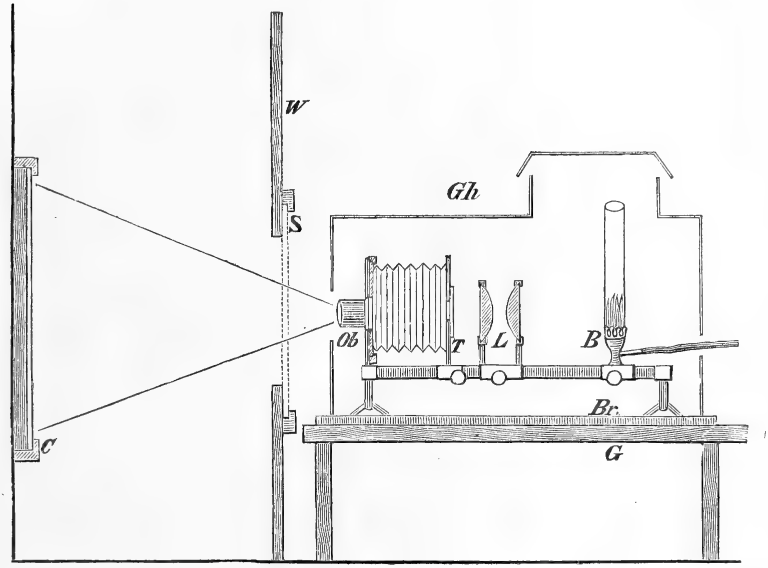


NELSON AND CURTIES'S PHOTOMICROGRAPHIC CAMERA.

To find out the length of exposure, use a Warnerke's sensitometer, in conjunction with the table and directions in Mr. Bousfield's 'Guide to Photomicrography.'"

Photographing Series of Sections.*—Dr. W. His photographs serial sections with a magnification of 10–20 diameters with the following apparatus:—A toothed bar carries at its front end a plate with the photographic objective Ob: a second plate, moved by a rack and provided with a central aperture, serves as object-carrier T: the two plates are united by bellows. The source of light is an Argand burner B, movable along the toothed stage. The light is concentrated by two plano-convex lenses L, with a

Fig 245.



diameter of 11·5 cm. and a focal distance of 8 cm. Diffuse light is avoided by the tin case Gh, in one side of which a broad valve or door is situated, in order to obtain access to the inclosed parts. The objectives used were a Steinheil's *antiplanatic* of 12 cm. focal distance or an *aplanatic* of 14 cm. The latter, though not so powerful as the former, gives a correcter and more definite image. Instead of a camera, the wall of the dark chamber W is used as a reception surface; the latter is divided into two halves and fitted with a door and shutter S. By means of S the light is thrown on or turned off the sensitized paper. The apparatus rests on a board Br which can be moved along the surface of the wooden stand G. This suffices for rough focusing. Finer focusing is obtained by moving the object-carrier T with a screw. Exact focusing is made by turning the objective, which works in a tube provided with a fine screw-thread. The sensitized paper is, if small, fixed down by small pegs; if large it must be fitted into a frame C, fastened to the wall. The image is first focused on a piece of white paper placed behind the glass plate of the frame, and, this done, the sensitized paper is introduced while the shutter S is closed. The paper employed is Eastman's silver bromide paper, which is sensitive enough to artificial light,

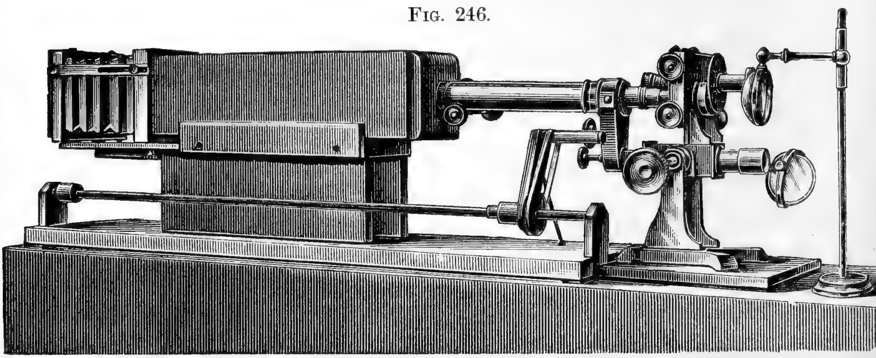
* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1887, pp. 174–8 1 fig.).

and requires but simple manipulation. The length of exposure varies with magnification and the diaphragm; with Steinheil's aplanatic of 14 cm. focal distance, with diaphragm 4 for a magnification of 10 times, 6–8 minutes are required. Thin sections require longer than thick or deeply stained specimens. All the necessary details of manipulation are given with each packet of the Eastman's paper, but it may be mentioned that after exposure the paper is moistened with water and the image developed with acetate of potash and sulphate of iron. It is then washed in acidulated water, and having been fixed with hyposulphite of soda, is frequently washed, and the sheet is then dried. The time occupied in taking four slides with twenty-five sections each, magnified 10 times, is from an hour to an hour and a quarter.

In addition to giving an accurate copy of the sections, the method is most useful for reconstruction of the image, and if before cutting Kastschenko's definition planes * are applied, the fine lines appear on every negative, and this renders the copies still more suitable and convenient for reconstruction purposes.

Ellis's Focusing Arrangement for Photomicrography.—Mr. John Ellis writes us:—"All the focusing arrangements for photomicrography have appeared so defective to me, that I venture to send a description and drawing of the one I use. The rod running the length of the camera carries

Fig. 246.



a loose arm, at the end of which is a roller, covered with indiarubber, which is made to revolve by an endless strap passing round a wheel upon the rod. The roller is kept in contact with the fine-adjustment screw of the Microscope by an indiarubber band attached to the base-board and the arm."

Nelson's Photomicrographic Focusing-screen.—This (the design of Mr. E. M. Nelson) is made by engraving the English and metrical scales, as well as a crossed diagonal, on the plane-glass plate which is used by nearly all photomicrographers. The engraving, which forms a convenient object to focus on, is a scale for measuring the magnifying power. The English scale is divided into inches, tenths, and half-tenths, and the metrical into cm. and mm. The scales are ruled horizontally, one inch apart, across the plate, one on either side of the cross made by the diagonals. The diagonals are not ruled at the points where they pass through the scales, in order that they may not interfere with the divisions.

Denaeyer, A.—**Résumé de la conférence publique sur les procédés de reproduction aux encres grasses des clichés photomicrographiques et des images d'objets scientifiques. Exposé d'un procédé nouveau de photolithographie, avec démonstrations.**

* See this Journal, *ante*, p. 511.

pratiques. (Résumé of the public lecture on the processes of reproducing with printing inks photomicrographic clichés and images of scientific objects. Description of a new method of photolithography, with practical demonstrations.) *Bull. Soc. Belg. Micr.*, XIII. (1887) pp. 182–5 (1 pl.).

HENSEN, V.—**Ein photographisches Zimmer für Mikroskopiker.** (A photographic room for microscopists.) *Kölliker's Gratulationschrift*, 1887, pp. 61–71 (1 pl.).

KING, Y. M.—**The Photomicrography of Histological Subjects.** *Journ. of Micr.*, VI. (1887) pp. 205–16, from *New York Med. Journ.*

MARKTANNER, G.—**Bemerkungen über Mikrophotographie.** (Remarks on photomicrography.) *Phot. Corresp.*, 1887, p. 237.

(5) Microscopical Optics and Manipulation.

Microscopical Tube-length, its length in millimetres, and the parts included in it by the various opticians of the world.*—Prof. S. H. Gage read a paper with the above title to the Pittsburg Meeting of the American Society of Microscopists.

"In the construction of microscopic objectives, the corrections must be made for the formation of the image at a definite distance, or, in other words, the tube of the stand of the Microscope on which the objective is to be used, must have a definite length. Consequently, the microscopist must know and use this distance or 'microscopical tube-length' to obtain the best results in using the objective in practical work.

In order to obtain the exact distance in millimetres for which objectives are corrected, and the parts of the Microscope included in this distance or 'tube-length,' the following questions were submitted to all the opticians of the world whose addresses could be obtained:—1. For what 'tube-length' do you correct your microscopic objectives? Please give the length in millimetres or inches. 2. Please indicate on the diagram on the opposite page (fig. 247) exactly what parts of the Microscope you include in 'tube-length.' From nearly all precise and satisfactory answers were received, and I wish to express here my appreciation of their courtesy. The answers received are given below, and indicated on the accompanying diagram.

TABLE *giving Length in Millimetres and showing parts included in 'Tube-Length' by various Opticians.*

Parts included in 'Tube-length.' See Diagram.		'Tube-length' in millimetres.
a–d	Grunow, New York	203.
	Nachet et Fils, Paris	146 or 200.
	Powell and Lealand, London	254.
a–d	C. Reichert, Vienna	160–180.
	W. Wales, New York	254.
b–d	Bausch & Lomb Optical Co., Rochester	216.
	Bézu, Hausser et Cie., Paris	220.
	Klönne und Müller, Berlin	160–180 or 254.
	W. & H. Seibert, Wetzlar	190.
	Swift & Son, London	165 to 228½.
	C. Zeiss, Jena	160 or 250.
a–g	Gundlach Optical Co., Rochester	254.
c–d	Ross & Co., London	254.
c–e	R. & J. Beck, London	254.
c–g	H. R. Spencer & Co., Geneva, N.Y.	254.
c–f	J. Green, Brooklyn	254.
c′–e	E. Leitz, Wetzlar	125–180.
	For Oil-immersions	160.

* Microscope, vii. (1887) pp. 289–92 (1 fig.).

A glance at the table and diagram is sufficient to show that there is about as great diversity as possible in the parts included in 'tube-length,' and that the length in millimetres, including these parts, is likewise very diverse. This has, doubtless, come about simply because there was no general standard, and each optician selected for himself a standard. For the sake of those who *use* the Microscope, it is hoped that a uniform standard may be chosen, or that, at most, but two standards should be decided on by all opticians. These two lengths in millimetres would probably best be 254 mm. for a long or English 'tube-length,' and 160 mm. for the short or Continental 'tube-length.' Furthermore, the same parts of the Microscope should be included in the 'tube-length,' and the parts included should be readily determinable by the youngest student. The parts included by six of the opticians named above, viz.: from the top of the tube (*b*) where the ocular is inserted, to the lower end (*d*) where the objective is screwed in, answer this requirement of simplicity. Without urging this as the best possible selection, it will readily be seen that this 'tube-length' may be easily measured where the ocular and objective are not in position, and that makers of stands who do not also make objectives could easily make the tubes of their Microscopes of exactly the right length for the objectives of all objective-makers. While it is true that the objectives of various makers are in mountings of different lengths, and therefore, other things being equal, tend to increase or diminish the actual or optical 'tube-length,' and thus to vary the magnification of the Microscope, if each maker would choose the length designated above (*b–d*) for which to correct his objectives in their mountings, then no matter how long or short that mounting might be, the microscopist would be able to measure off the right length on the tube of his Microscope, for which the objective was corrected, and having this length once determined, it would not need to be changed when an objective of different length of setting was used.

FIG. 247.

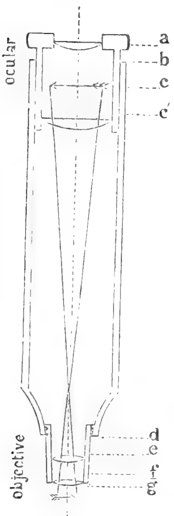


Diagram showing the parts of the Microscope included in 'Tube-length' by various opticians of the world. (See table above.)

Furthermore, the convenience of the microscopist and uniformity in 'tube-length' would be both subserved if the eye-pieces or oculars were made '*parfocal*,'* that is, the settings be so adjusted that the lower focal points of all the eye-pieces shall be at the same level when in position in the tube of the Microscope, then no refocusing of the Microscope would be necessary upon changing oculars. If also the level of the 'lower focal points' of the different oculars were made to fall at the level of the top of the body-tube of the Microscope, one end of the so-called 'optical tube-length' would be always determinable, and correspond with one end, that is the upper end, of the tube of the Microscope.

So long as no common standard is employed, it seems to the writer that every objective should be accompanied by a statement and a diagram indicating the tube-length in millimetres for which it was corrected, and showing also the parts of the Microscope included in this measurement.

* See this Journal, 1886, p. 1050.

If the objective is unadjustable, a statement should also accompany it, giving the thickness of cover-glass for which it was adjusted."

On this paper the editor of 'The Microscope' * writes as follows:—

"Every microscopist will thank Prof. S. H. Gage for publicly calling attention, in his article, read at the recent meeting of the American Society of Microscopists, to the remarkable lack of uniformity which exists among opticians in their standards of tube-length and in the parts which they include in their computation of it.

All who seek and desire accuracy in their objectives, understand that they are corrected for a definite tube-length, and that perfect performance is possible only when that tube-length is used. The lack of knowledge, even among expert microscopists, of the exact length for which given objectives are corrected, and the difficulty of measuring it from the hidden points adopted by many makers, have led them frequently to disregard the perfect accuracy which they should observe in adjusting their Microscopes, and to be satisfied with an approximation to the proper tube-length. Text-books and makers' catalogues, also, are almost silent in the matter, and microscopists who use the Microscope in their every-day business, but who give but little attention to the optical principles of its construction and working, have remained in ignorance of any necessity for such an adjustment. Prof. Gage's article, with its complete tables, brings the subject forcibly to the mind of every microscopist, and makes clear the necessity of the adoption by makers of a uniform tube-length, and of uniform and easily accessible points between which to compute it.

Prof. Gage, in his remarks, rather hesitated to ask opticians to change their various standards to a common one. From conversations with several opticians we have learned that there are no serious objections to such a change, and we urge upon manufacturers that it be made. The committee appointed by the American Society of Microscopists to investigate the subject and report at the next meeting, may, if their judgment agree with ours, accomplish much to this end.

A tube-length of 254 mm. is generally spoken of as the standard, and is adopted by the majority of opticians, and this, we believe, should be the only one chosen.

In determining the parts to be included in the measurement of tube-length there is more opportunity for diverse views. The most scientific measurement probably, would be between the optical centre of the objective and the optical centre of the ocular. These points are, however, the most difficult to determine, and they vary with each objective and each eye-piece. The same objections hold good with any measurement which has for its lower extremity any part of the objective. Uniformity in the length of the setting, and the position of the lenses of objectives, is practically impossible. The lower extremity of the tube (*d* in Prof. Gage's figure) is the only lower fixed point, and is the point selected by all but a very few opticians.

For the upper point *c* and *c'* can be excluded, *a* and *b* being the only points that are fixed and accessible, and the majority of opticians include the parts between one of these points and *d* in their measurement of tube-length. These points can be determined by the youngest student, and variations in objectives will not affect the length. Prof. Gage prefers the measurement *b* to *d*. This is, perhaps, the simplest, but is open to the objection that different opticians use eye-pieces of different construction. European makers use the Continental pattern, in which the eye-lens is but 1 or 2 mm. above the body, while Americans prefer the eye-piece with

* Microscope, vii. (1887) pp. 305-6.

neck, which brings the eye-lens 12 to 15 mm. above the body. This, of course, increases the optical tube-length just so much, and it would be necessary for opticians to indicate on the objective whether it was corrected for the Continental or the American ocular. With the measurement *a* to *d* each microscopist could easily adapt his tube-length to suit either style of ocular.

We can join Prof. Gage also in his plea for 'par-focal' oculars. Their adoption would be another step in the development of a uniformity in apparatus, which is of so great convenience to busy workers, and which tends so much to harmonize the work of various manufacturers.

We believe that these subjects, so tersely brought foward by Prof. Gage, should be agitated until manufacturers adopt them; and to further this end we shall be glad to publish correspondence from all interested opticians and microscopists."

Measurement of Power.*—Mr. E. M. Nelson says that it is sometimes useful to know the "initial" magnifying power of an objective, by "initial" power meaning the size to which an image will be magnified by an objective alone when projected on a screen at a distance of 10 in.

In practically measuring this power, it will be found a more accurate plan to increase the distance to, say, 60 in., and divide the result by 6. These measurements are very easily performed when one has a camera, but it is not so easy to do them without. Therefore, another and somewhat loose way of getting at the initial power is adopted, viz. as follows:— Measure the combined magnifying power of the objective, and say 2 in., or A, eye-piece, and divide the result by 5. This method would do very well if the exact multiplying power of the eye-piece was 5, and if the length of the body remained constant. As it is not an easy matter to find out the exact multiplying power of an eye-piece, Mr. Nelson recommends any one desirous of knowing this to measure or get measured the initial power of one of his objectives; then measure the combined power of this lens and his eye-piece, paying great attention to his tube-length during the operation. This will give him once for all the multiplying power of his eye-piece with that tube-length. He will then be in a position to ascertain the initial power of any other lens with that eye-piece and the same tube-length. But as the optical tube-length may differ from the actual tube-length, and does differ to a certain extent, with objectives of ordinary construction, this process is not so simple as it appears. In order to get fairly accurate results with the higher powers, a certain percentage must be deducted. To give some examples:

Thus, 1 in. at 60 in. increases the image of ·01 in. to ·66 in., its power, therefore, is 66, which at 10 in. = 11 = initial power. The combined power of this lens with an A eye-piece is 55, which gives 5 as the multiplying power of the eye-piece. Now, if the combined power of this eye-piece with a 2/3 = 75 we may assume the initial power of the 2/3 is 15.

If, however, we treat higher powers in the same way, we shall get too high values. Thus the combined power of a 1/4 and the eye-piece is 203; dividing by 5 we get 40·6 as the initial power, whereas 39·3 is the real power.

Again, the combined power of a certain 1/12 and the eye-piece is 600, which, divided by 5, gives 120 as its initial power, whereas it is in reality 113·2. The empirical rule Mr. Nelson employs is to deduct 2 per cent. for 1/2, 3 per cent. for 1/4, 4 per cent. for 1/6, 6 per cent. for 1/8, 1/12,

* Eng. Mech., xlvi. (1887) pp. 188–9.

&c. Thus taking the 1/4 above and deducting 3 per cent. from the 203, we get 197, which, divided by 5, gives 39·4, a result very near the truth.

A certain 1/8 gives a combined power of 450, deduct 6 per cent. = 423, divide by 5 = 84·6, the actual being 85. For short bodies of $6\frac{1}{3}$ in., or Continental size, a different percentage must be employed. The following gives fair results:—2 per cent. for 1/2, 4 per cent. for 1/4, 6 per cent. for 1/6, 8 per cent. for 1/8, and 10 per cent for 1/12.

Method of Intensifying the Resolving Power of Microscope Objectives.*—Mr. G. D. Hirst describes a simple way of vastly improving the definition of objectives on close-lined test objects, which has lately come under his notice. The credit of the discovery is due to Mr. Francis, of Sydney.

Take a valve of, say, *Amphipleura pellucida*, and, having got the best results obtainable with mirror and condenser, let the analysing prism belonging to the polarizing apparatus be placed over the eye-piece, and rotated until it darkens the field, which it will do, though not to the same extent as when used with the polarizing prism. On carefully focusing the diatom, the lines will show themselves with an extraordinary increase of definition. Valves that without the aid of the prism only show a washy sort of resolution, will now show the lines as black as the bars of a gridiron.

On *P. angulatum* by central light the result is also splendid. The same effect can also be obtained, though perhaps to a slightly inferior degree, with the objective, or, as it is placed in some stands, in a sliding box in the body of the Microscope; in the latter case, as it cannot be rotated, the valve of *A. pellucida* should lie horizontally. For general purposes, it is better for the prism to fit over the eye-piece, as besides giving better definition in that position, with a diatom like *P. angulatum* and prism over the objective, the diffraction spectra would be cut out of the top and bottom of the back lens and the effect spoiled. Of course, in the case of *A. pellucida*, with the valve lying horizontally, it does not matter, as the dioptric ray and single spectrum are not cut off in any way by the prism or the box in which it is set. The prism has the effect of greatly diminishing the light of the dioptric beam; at the same time it scarcely touches that transmitted by the diffraction spectra.

The application of the prism will not of course make an objective resolve a test beyond the reach of its aperture; but it often happens that in the case of close-lined objects we can see the spectrum at the back of the objective when the lines cannot be seen in the object itself. It is then that the prism shows its power, as its use will at once bring out the lines with the greatest ease and sharpness.

Mr. E. M. Nelson † found, while investigating the matter, that the diffraction spectrum of *A. pellucida* (illuminated by oblique beam from oil-imm. achromatic condenser, and with a water-imm. 1/12) showed all the green, but no red. On examining the spectrum through the analysing prism without an eye-piece he found that when the prism was in a line with the dioptric beam and the diffraction spectrum, the brightness of the green was intensified. On replacing the eye-piece, and viewing the image through the prism used above the eye-piece, as directed by Mr. Hirst, there could be no doubt that the transverse striæ were much sharper and blacker than when viewed without the prism. The prism must, of course, be kept in a line with the dioptric beam and the diffraction spectra. Should the prism be turned across, even if it does not cut off aperture, the definition will be impaired.

* Eng. Mech., xlvi. (1887) p. 232. † Ibid., p. 254.

He next changed the water-imm. 1/12 for a water-imm. 1/16 of less angle, which would barely resolve the *A. pellucida*—that is to say, would only resolve it in patches, and not from end to end. On examining this with the prism, he found that the parts which were unresolved were still unresolved; but those parts which were resolved were intensified.

"The image of *A. pellucida* with an apochromatic 1/8 (1·4 N.A.), my new eye-piece, and the prism is something very fine, such as I have never seen before."

He also tried the prism with several very subtle direct light tests, but cannot say that he found any improvement in the image. On the whole, he should think this class of objects would be seen better without the prism. Probably the efficacy of the prism, when used with a lined test, lies in the fact that it intensifies the diffraction spectra when it is placed in a certain direction to it.

BROKENSHIRE, F. R.—**Measurement of Magnifying Power of Micro-objectives.**
[Complaint that the subject has not received the elucidation he anticipated.]
Engl. Mech., XLVI. (1887) p. 300.

DIDELOT, L.—**Du pouvoir amplifiant du Microscope, détermination théorique et expérimentale: suivi d'une table à quatre décimales, des inverses de 1000 premiers nombres de 0·01 à 10·00.** (The magnifying power of the Microscope. Theoretical and experimental determination: followed by a table to four places of decimals of the reciprocals of 1000 prime numbers from 0·01 to 10·00.)
2nd ed., 90 pp., 2 pls., 8vo, Paris, 1887.

GARIEL.—**Quelques généralités sur les instruments d'optique.** (Some general considerations on optical instruments.)
Arch. Sci. Phys. et Nat., XVIII. (1887) pp. 339–41.

HODGKINSON, A.—**On the Diffraction of Microscopic Objects in Relation to the Resolving Power of Objectives.** *Proc. Manch. Lit. and Phil. Soc.*, XXV. (1886) p. 263.

(6) Miscellaneous.

"The Microscope as a factor in the establishment of a constant of nature."—The following is the first part of the Presidential Address delivered by Prof. W. A. Rogers before the American Society of Microscopists at the Pittsburg Annual Meeting:*—

"Microscopy is a cosmopolitan science. We may go farther than this, and say that microscopy is more nearly cosmopolitan in its character than any other science. If I did not believe this to be true I should not have consented to occupy the honourable position which I now hold by your suffrages, for there are many members of this Society to whom the honour more justly belongs by virtue of greater familiarity with the technics of our science. I suppose that I am indebted to this expression of your confidence on account of the use which I have made of the Microscope as an essential factor in a single line of research.

It is the glory of our science that the Microscope supplements the natural vision to such an extent that we can submit nearly every theory, nearly every deduction from experiment, nearly every fact of observation, to the supreme and only test by which a real truth in nature can be established, viz. through the medium of one of the senses with which we have been endowed by the Creator. It has been said that microscopy has no claim to be regarded as a science, and that the Microscope is simply an instrumental agent occupying with respect to other sciences a position similar to that which the telescope sustains in its relation to astronomy. A convincing answer to this criticism is found in the fact that the telescope is limited in its application to a comparatively narrow field of research. Where the telescope answers a single question the Microscope answers a

* Microscope, vii. (1887) pp. 257–61. Corrected by Prof. Rogers.

thousand. Spectroscopy has become a recognized science, not so much because of its revelations in regard to the nature of light, as on account of the application of the spectroscope as an instrument to the study of the physical properties of matter and of motion not only on the earth, but in worlds other than our own.

In discussing the question whether microscopy can be regarded as a science, we must always bear in mind the fact that a science is only a convenient name *for a group of similar laws of nature*, and that the term is properly applicable not only to the development of these laws, but to their application to the useful economies of life. Thus we have the science of engineering, in which mathematical analysis is as much an essential part as skill in mechanical construction. But this analysis would serve no useful purpose if did not rest ultimately on facts of observation.

The limitations which necessarily belong to a definition of physical science are clearly expressed by Tate in his most admirable treatise on Heat. He says: 'Nothing can be learned as to the physical world save by observation and experiment, *or by mathematical deductions from data so obtained.*' Now the Microscope as an instrument of research stands unrivalled, not only in respect to the precision of the observations made with its aid, but also in the universality of its application in furnishing what Tate calls 'the data so obtained.'

Each succeeding year witnesses an extension of the range of its applications. Within a few years, while retaining its claim as an essential factor in scientific research, it has also become a very material aid in many mechanical industries. It is a common impression that the Microscope is too delicate an instrument to be used in the ordinary operations of mechanical construction, and that the apparent necessity of using transmitted light for the purpose of illumination is an absolute barrier to any extended employment of the instrument. The latter difficulty is entirely obviated by the use of the opaque illuminator invented by Tolles, by which a bright metal surface can be examined with the utmost ease, while actual experience has shown that it is by no means necessary that the instrument should be mounted upon massive piers insulated from surrounding objects.

I cannot more forcibly combat this impression than by referring to two cases within my own experience. The 'Proceedings' of the Society of Mechanical Engineers for 1884 contains a description of a method of cutting a screw in which each thread is made to correspond in pitch with equal subdivisions of a standard yard traced upon a metal bar. The screw for the engine constructed for Cornell University was made in this manner. Prof. Anthony has shown that the maximum accumulated error of the screw does not reach 2 mikrons for a limit of 20 inches, while the actual error at any selected point will not reach 1 mikron. This screw was cut in the manner indicated, in the third storey of a building occupied by machinery, which produced a decided tremor in every room. It was only found necessary to make the attachment of the Microscope to the compound rest of the lathe very firm, and to brace the bed of the lathe very securely from the floor.

The writer was recently called upon to 'level up' the bed of a very heavy planer, having ways 18 ft. in length. Several days had already been spent in securing as good an adjustment as could be obtained with the aid of a spirit-level of special construction. A plank 22 ft. in length, 8 in. in width, and 2 in. in thickness was set up edgewise beside the platen of the planer, but insulated from it. A groove 1/2 in. wide and 1/2 in. deep was ploughed in the upper face of the plank, and after having stopped both ends, the groove was filled with mercury. The surface of the mercury then

formed an invariable plane of reference. The Microscope was securely attached to the platen and adjusted for sharp focus upon the surface of the mercury at one end. The platen was then moved along until the Microscope occupied a position near the other end of the groove. This end was then adjusted by elevation or depression as required, until the surface of the mercury was sharply in focus. After two trials it was found that the surface of the mercury was at the same constant focal distance from the Microscope as indicated by the sharpness of definition. Notwithstanding the fact that extreme care had been taken in the original adjustment by the aid of the spirit-level, it was found that as the platen moved towards the central part of the bed the focus became more and more indistinct, indicating that the central part was too low. The proper elevation was then made at these points by means of heavy set-screws, when it was found that the mercury was sharply in focus under the objective throughout the entire range of motion. As a check upon the accuracy of the adjustment a surface-plate 8 ft. in length was now planed, when it was found that the deviation from a true surface did not at any point exceed the third part of the thickness of tissue paper. Two facts of considerable importance are to be noticed in connection with this experiment. First, that the time occupied for the complete adjustment was only twenty-five minutes; and, second, that during the entire operation the machinery of the shop was running at half-speed.

These and similar observations have led the writer to advocate a more extended use of the Microscope in the every-day work of the machine shop. By attaching the Microscope firmly to the slide-rest of the lathe, the ordinary operations of turning shoulders to a given length, and of cylinders to a given diameter, can be more expeditiously, more exactly, more economically performed than by the usual method.

It is freely admitted by mechanicians that a decided advance in mechanical construction would be made by the employment of uniform measures of length. This can be easily and profitably accomplished in any well regulated shop, employing as many as fifty hands, by delivering from a standards room any desired unit of length, in the same way that tools are delivered from a tool-room. The expense of a comparator, from which any measure of length could be obtained within a limit of time which would not ordinarily exceed one minute, would not be great. If this comparator were placed in charge of a person familiar with its use, and in a convenient location, any workman could have a calliper set for him in half the time that would be required in setting it to a scale by the usual method; the precision would be incomparably greater, and absolute uniformity would be secured in every dimension of length employed. The various points to which I have briefly called attention are to be considered simply as illustrations of the many ways in which the useful service of the Microscope may be extended.

In the address which I am called upon to make this evening, as President of the American Society of Microscopists, I have selected a single application of the Microscope in scientific research. *I beg to call your attention to the Microscope as a factor in the establishment of a constant of nature.*

If a bar of metal, which has the faces of each end parallel and at right angles to its axis, is submerged in melting ice, the perpendicular distance between the two faces may be said to represent a definite unit of length at the temperature of 32° F. or of 0° C. If this distance is identical in length under similar conditions with a certain bar of platinum now deposited at the International Bureau of Weights and Measures at Breteuil

near Paris, and designated the '*Mètre des Archives*,' the length of the bar is said to be one metre. If now the bar is submerged in a liquid which has throughout its entire mass a temperature one degree higher than that of melting ice, its length, after it has reached the same temperature as the liquid, will be increased by a certain fraction of its entire length. If this length is subdivided into one million equal parts, and if the increase is, for example, ten parts in one million, the coefficient of expansion of the metal is said to be ten mikrons. If the increase in length proceeds uniformly for each and for every increment of temperature, we can say, for example, that the length of the bar at 100° C. will be 1000 mikrons, or one millimetre greater than it was at 0° C. We can also say that if the temperature of the entire mass of metal is again reduced to 0° the length of the bar will be exactly the same as it was before the increase of temperature took place.

There is some evidence that when certain metals are exposed to very violent changes in temperature, as when zinc is removed from a temperature of 100° C. and is submerged in melting ice, the molecular arrangement of the metal is disturbed to such an extent that the return to its original condition may be delayed for several days, and even for several weeks; but it cannot, at the present time, be positively asserted that the return will not ultimately take place.

It will be noticed that the definition of the coefficient of expansion which has been given, viz. the increase in length due to an increase of temperature from 0° to 1°, contains the important limitation that the entire mass of the metal shall have reached the temperature of 0°."

We have no report of the remaining part of the address, except the following abstract of the 'Pittsburg Dispatch,' which gave an account of the proceedings of the meeting:—

"Prof. Rogers chose as his subject, 'A demonstration of the fact that metals may be safely employed to measure temperature by means of their expansion under an increase of temperature.' He began with a defence of microscopy as a science, and gave a brief review of the various ways in which the usefulness of the Microscope may be extended, especially in the direction of mechanical constructions. He then proceeded to discuss the Microscope as a factor in the determination of a constant of nature, which was practically the real subject of his address. In general the problem to be considered is, 'Do metals expand uniformly under every variation of temperature?' After limiting the definition of the term 'constant of nature,' to the three bars of metal investigated, viz. a bar of Baily's metal, composed of 16 parts copper, $2\frac{1}{2}$ parts tin, and 1 part zinc; a bar of Jessup's steel and a bar of glass made by Chance & Sons in 1870 for the British Board of Trade, he gave an account of the various kinds of errors to which observations of this class are liable. Incidentally he referred to the different kinds of thermometers in use, and the manner in which they are constructed, relating many interesting experiments showing the real value of their indications, and how they sometimes fail to register correctly on account of atmospheric changes and conditions. After describing the methods employed to detect the errors of the thermometers employed to measure the temperature at which these three standards of length were compared, he gave an account of the investigation by which he determined that the relative coefficients of expansion of these metals are constant for all temperatures between − 5° and 95° temperature. He made 293 sets of observations, nearly all of them about half an hour after sunrise on clear days, and a little later on cloudy days. The time at which the comparisons between the lengths of these standards were made, was defined by

the speaker to be the critical point of no variation of temperature when there was an equilibrium between the temperature of the bars of metal, of the surrounding air, and of the thermometer employed. As a result of observations extending from December, 1886, to July, 1887, the conclusion was reached, first: 'That the relative coefficients of expansion of these metals are really constant for ordinary temperatures; and second, that the values of the absolute coefficients have not changed since 1881.'" *

Fasoldt's Rulings.†—Mr. C. Fasoldt writes as follows:—"A gentleman interested in microscopy lately called my attention to an item in the report of the Microscopical Society of Washington, D.C., in the April number of the 'American Monthly Microscopical Journal,' p. 77: 'Dr. Schaeffer asked if any of the Society had seen Fasoldt's ruling on glass. Prof. Seaman said Fasoldt had done some fine work, but the finest was that done by Prof. Rogers,' &c.

I was not aware that I was recognized as an amateur in mechanics, and that I imposed on the world with inferior products; neither has a commission of any exhibition ever rendered such a verdict. Contrary to that, in World, International, and State Exhibitions I was always recognized as master of the masters, which is shown by the following first-class awards:—

Prize Medal of Honour and Diploma of Merit awarded at the Centennial Exposition of 1876. Also First Prize Medal and Diploma, International Industrial Exhibition, Buffalo, N.Y. Three First Prize Medals, Utica Mechanics' Association. First Premium Medal, Syracuse Mechanics' Association. Silver Medal and Certificate of Highest Merit of New York State.

Regarding the sentence that I do not publish my method of ruling, I do not want to dictate to other persons what methods to use to accomplish a certain work—in somewhat by showing and illustrating my machine—neither do I want to contradict those who attempt to illustrate how work is and should be done. I claim that everybody has the privilege to construct and make their own Microscope, measuring and illuminating apparatus, ruling machine, and machinery to make those and all other devices that anybody wished to make for private or general public use, as I have done.

As it is proper for a man to uphold and prove what he has said, or either retract such quotation, I would ask Prof. Seaman to send the following rulings made by Prof. Rogers. All test-plates should be ruled in bands, beginning with and running up every 10,000 to the denomination as given below.

1 plate ruled up to 200,000, or 250,000 lines per inch
1 " " " 120,000 "
1 " " " 6,000 "
3 stage mic. ruled 1, 10, 100, 1000 per inch.
3 stage mic. ruled 100, 1000, 5000, 10,000 lines per inch.

When I will appoint a committee of four to measure and resolve them. And the Professor can appoint his committee and do likewise with my rulings.

We have numerous times resolved 200,000 and over. I have the facilities to do it with, and measuring likewise."

* Cf. Amer. Mon. Micr. Journ., viii. (1887) pp. 196–7, for a criticism on this address, so far as it defends the claim of microscopy to the title of a science. "We see no advantage to be gained by naming a science which does not exist. In a truly scientific sense there is no such thing as a science of microscopy as defined by Prof. Rogers."

† Amer. Mon. Micr. Journ., viii. (1887) pp. 175–6.

It would be very interesting if Mr. Fasoldt would tell us how he resolves the "numerous lines, 200,000 and over." Until he does this his claim to be recognized as a "master of the masters" cannot be admitted.

Nägeli and Schwendener's 'The Microscope in Theory and Practice.'* —This translation of Prof. Nägeli and Schwendener's well-known treatise on the Microscope is at last published, after suffering almost unprecedented vicissitudes. In addition to disasters to the manuscript, the whole book, after being printed off, was burnt in 1884, in a great fire in the City in which the printer's works were involved. Those responsible for the publication were so far discouraged that they practically abandoned the matter, and it is due to the enterprise of the publishers that the translation is after all given to the English-speaking public. Although advances have been made since the book was written in several directions, notably by Professor Abbe, Nägeli and Schwendener's work will always be a classical landmark in the history of the Microscope, and will be more especially valuable to English microscopists as the first book in their language to deal with the Microscope on a scientific basis unadulterated on one side by descriptions of the various forms of Microscopes and microscopical apparatus, or on the other by a review of the microscopical subjects of the Animal, Vegetable, and Mineral Kingdoms. As such we may commend the book to a place in every microscopical library.

The following is extracted from the preface:—

"This translation of Nägeli and Schwendener's well-known treatise 'Das Mikroskop' was commenced by Mr. Frank Crisp, Secretary of the Royal Microscopical Society, immediately after the publication of the last (German) edition (1877), with the intention—as indicated by him in a communication to the Quekett Microscopical Club—of filling up a blank in English miroscopical literature in regard to the scientific technical treatment of the theory of the Microscope, in which English text-books were so deficient.

The student refers in vain, even at the present date, to English works on the Microscope for explanations of the theory of the construction of objectives, eye-pieces, &c., or for the discussion of the phenomena of diffraction and polarization in their connection with the Microscope, or for any scientific treatment of the question of interpreting microscopical images or the theory of microscopic observation. These subjects are dealt with systematically in German works only, and notably in that of Nägeli and Schwendener.

The translation was thus undertaken with a view to placing before English readers the then best known collective exposition or technical treatment of these points by German writers.

When the rough draft of the translation was completed, the first five sheets (80 pp.), were revised and put in type, but in consequence of prior claims upon his time in connection with the Royal Microscopical Society, Mr. Crisp was compelled to relinquish the task of further revision, and of passing the volume through the press, a labour which was undertaken by Mr. John Mayall, jun., one of the editors of the Society's Journal.

Just as the printing was completed, a fire destroyed the premises of the printers, and the whole of the printed sheets of the volume were burnt, except one set as far as p. 374, which the publishers had retained in their possession, together with a few of the woodcuts.

* Nägeli, C., and Schwendener, S., 'The Microscope in Theory and Practice' (translated from the German), xi. and 382 pp. and 210 figs. (8vo, Swan Sonnenschein, Lowrey & Co., London, 1887).

Under these circumstances the publishers had to consider the alternatives (1) of abandoning the issue of the volume; or (2) of incurring the additional expense of re-translating the portion of the work totally lost by the fire, replacing the missing woodcuts, and reprinting the whole; or (3) of reprinting as far as p. 374 only, omitting therefore Part VIII. (Microphysics), Part IX. (Microchemistry), and Part X. (Morphology). It was finally decided to adopt the last course, hence the present issue.

Whilst it is much to be regretted that this translation should only now be issued, microscopists will no doubt appreciate the advantage of having a version in English of a work which has received high commendation from both English and foreign critics; and it is hoped that this volume may be supplemented before long by an English version of the further researches in microscopical optics by Professor E. Abbe, of Jena, which have extended so much our knowledge of the matters dealt with in Nägeli and Schwendener's work."

Death of Mr. T. Bolton.—We much regret to have to chronicle the death of Mr. T. Bolton, a Fellow of the Society. Mr. Bolton's intense devotion to microscopical matters is well known to all microscopists, and the perseverance with which he carried on his supply of microscopical organisms was beyond all praise. His services in this connection had materially added to our knowledge of the fresh-water and other fauna of this country, and he was the discoverer of forms not only new to England but new to science. He was ever ready to assist microscopists and naturalists to the utmost of the means at his command, without, as we have often found, making any sufficiently adequate pecuniary demand in return. His death is a serious loss to microscopy.

In 1884 the Council of the Royal Society placed 50*l.* in the hands of Prof. Ray Lankester for the purpose of employing Mr. Bolton to collect material for an investigation of the fresh-water fauna of the midland counties; and at the Fisheries Exhibition a gold medal was awarded to him for an exhibition of minute life relating to the food of fishes. It will be remembered that last year, in response to a memorial signed by many eminent men of science, a Civil List pension of 50*l.* per annum was granted to him.

"A QUEKETT CLUBMAN."—**The Student's Handbook to the Microscope:** A Practical Guide to its Selection and Management. 72 pp. and figs., 8vo, London, 1887.

ALESSANDRI, P. E.—**Il Microscopio e sua applicazione alla Merceologia e Bromatologia.** 173 pp. and 230 figs., 8vo, Milano, 1886.

American Society of Microscopists.—Pittsburg Meeting.
St. Louis Med. and Surg. Journ., LIII. (1887) pp. 229–34.

BREZINA, A.—**Das neue Goniometer der K.K. Geologischen Reichsanstalt.** (The new goniometer of the I.R. Geological Reichsanstalt.)

[The optical part is thus described:—"The observing telescope is provided with a Huyghenian eye-piece, which can be moved to or from the objective, so that by inserting a lens in front of the objective the observer is able to use the whole system of lenses as a Microscope, and by approaching the eye-piece towards the objective to convert it into a telescope. In this way the connection between the image of the signal and that of the face may be tested in crystals with numerous faces. Since, however, the telescope may be raised or lowered, by which movements its distance from the axis of the circle is changed, the lens must also be capable of movement towards or from the axis. For this purpose the lens-holder is made to slide upon the telescope tube."]

Jahrb. Geol. Reichsanst., XXXIV. (1884) pp. 321–34,
Abstr. in *Neues Jahrb. f. Mineral.*, II. (1887) pp. 239–40.

[COPE, E. D., and KINGSLEY, J. S.]—**Wanted a Definition of a "Philosophical Instrument."**

[Complaint that with the U.S. Custom officials a hydrometer is a "philosophical instrument," while a thermometer is a "manufacture of glass," paying a higher

duty, while "Microscopes and microtomes are 'manufactures of metal,' as ruled by the Washington wiseacres in opposition to the opinions of the best scientific men of the country. . . . A more reasonable interpretation of existing laws, or better, a revision and a reduction of the present duties, would tend generally towards the advancement of American science and the promotion of American honesty."]

Amer. Natural., XXI. (1887) p. 922.

CUTTER, E.—**[The Microscope and Old Age.]**

["I hope that the Microscope may not be relegated to the younger members of our profession alone. It is an instrument for old age. Ehrenberg worked with his Microscope up to within a few days of his death. The focusing accommodates the defects of vision. Moreover, it is a comfort and solace to an aged physician to quietly explore the mysteries of the unseen world he has been dealing with microscopically during a long and laborious life. May it be a good preparation for that endless life where we shall no longer see through a glass darkly."]

Microscope, VII. (1887) p. 284.

GORECKI.—**Du Microscope appliqué à l'étude de la Minéralogie et de la Pétrographie. Minéralogie micrographique.** (The Microscope applied to the study of mineralogy and petrography. Microscopical mineralogy.) 8vo, Paris, 1887.

Microscopical Studies, Pursuit of, by Amateurs.

[Discussion of the question "How can a man who uses the Microscope, and studies pursued by its aid as a means of recreation, retain his interest in the subject?"]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 197–8.

Microscopy in Calcutta. *Sci.-Gossip*, 1887, pp. 229–30.

NEUMANN, C.—**Die Brillen, das dioptrische Fernrohr und Mikroskop.** Ein Handbuch für praktische Optiker. (Spectacles, the dioptric telescope and Microscope. A handbook for practical opticians.)

xxxii. and 232 pp., 95 figs., 8vo, Wien, Pest, Leipzig, 1887.

[OSBORN, H. L.]—**Microscope in Medicine.**

Amer. Mon. Micr. Journ., VIII. (1887) pp. 155–6.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XXV., XXVI., XXVII., XXVIII.

[Butterfly dust; villi and beads; its isolated beading and reticulations; reticulations and crossbars; ultimate beading and woof.]

Engl. Mech., XLVI. (1887) pp. 101–2, 173–4, 245–6, 291–2 (4, 10, 5, and 8 figs.).

VERLOT, B.—**Le Guide du Botaniste herborisant.** (Guide for the collecting botanist.)

[Contains descriptions of Microscopes, &c.]

3rd ed. with introduction by Naudin, xvi. and 776 pp. and 34 figs., 12mo, Paris, 1886.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Chætomium.†—For the cultivation of *Chætomium Kunzeanum*, says Dr. F. Oltmanns, plum decoction is more suitable than that of dung, as bacteria develope in it less easily. In order to determine whether the formation of a pollinodium ceases in the ascogonium, the examination of a dead cultivation does not suffice; recourse must be had to cultivations which allow continual observation of a particular carpogonium. Cultivations in moist chambers in hanging drops as they are usually carried out are impracticable, for the fungus stands in need of much oxygen. The mycelia are rarely brought to the fructification, for before this occurs a cessation of their general growth takes place, and even if the perithecia are actually formed it is not of much use, as these prefer to arise from mycelia projecting into the air, or are as near the culture-drops and air as possible —positions unattainable with high powers. To observe an ascogonium for a long time, nothing remains but to keep the ordinary slide-cultivations in the usual way under moist bell-jars until spores are formed. A suitable

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Bot. Ztg., xlv. (1887) Nos. 13–7 (1 pl.). Cf. this Journal, *ante*, p. 791.

ascogonium is then sought for under the Microscope, and the position of the slide upon the stage noted by means of a piece of paper stuck thereon. This device enables us to remove the slide and replace it under the bell-jar for further growth, and thus the stages of development may be examined without difficulty. Medium powers (Zeiss D, Oc. 4) are only available, and these do not meet the requirements of all cases. If the pollinodium be evident, it may perhaps be followed up with this objective. The younger parts can be observed until the brown hairs appear, after which their growth stops. In selecting ascogonia for observation, such as are quite immersed beneath the culture-fluid must be chosen. But as the fungi stand in need of much oxygen, they usually die if, when removed from the culture-drops, they do not receive sufficient air. From the moment when the perithecium is quite closed it becomes more difficult to follow the fate of the ascogonium.

From very small perithecia some knowledge may be derived from cleared up sections. It may then be noticed in young fruit-organs in which the hyphæ almost completely close up that the ascogonium is quite unchanged. For further examination the assistance of the knife is required. Axial longitudinal sections may be made in the following manner:—Pieces of elder pith cut smooth on one side are soaked in plum decoction until quite saturated therewith. The process, which is slow, may be hastened by frequent and prolonged boiling. Upon the smooth side of the pieces thus prepared spores are sown; these develope so that the perithecia stand vertical to the pith-surface. The fungi, having sufficiently grown, the piece of pith is laid in osmic acid; after hardening they are washed and then imbedded in glycerin jelly. It is also advisable to shave off a thin layer which carries the perithecia and imbed it in glycerin jelly. In both cases the gelatin is hardened in spirit, and then longitudinal sections of the perithecia are made. Imbedding may also be made in ordinary gelatin and in celloidin, but the latter is only suitable for young perithecia. Orienting perithecia under a dissecting Microscope and fixation on elder pith is only possible in the adult stages where the ascogonium formation has already begun, as in this case there is a safe criterion between apex and base. The author finds, too, apart from the fact that the ascogonium does not always lie centrally, and that every axial section does not afford correct information as to the relation of the carpogonium, that it is difficult to decide whether a section is accurately axial or not.

Osmic acid facilitates the examination, as it stains the hyphæ of the carpogonium brown or brownish yellow. The same colouring also appears in the old cells which proceed from the ascogonium.

Some Novelties in Bacteriological Apparatus.*—(1) *New form of Incubator.*—Dr. M. Schottelius has devised an incubator which, though unprovided with a gas-pressure or thermo-regulator, does not vary summer or winter more than 0·15°. The incubator contains two approximately cubical compartments (50 cm.), and consists of a double-walled box of zinc plate 1·37 m. long, 0·80 m. deep, and 0·80 m. high. Between the double walls circulates a layer of water 10 cm. thick, except at the top, where the layer is 20 cm. thick. The box is subdivided by a median partition, also double-walled and filled with water. The capacity of each chamber is therefore about 1/8 cubic metre. Access to the chamber is obtained by two double-walled zinc doors filled with a layer of ashes 10 cm. thick. The doors are placed at opposite ends of the long sides of the incubator. At the lower part of one of the shorter sides is a tap for letting off the water. Between the inner wall of the door and the incubator space is a

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 97–102.

plate of glass fitted in a frame of wood and covered with felt. The incubator is encased in wood, and stands 55 cm. high. Three thermometers, each 72 cm. long, are employed to indicate the temperature of the water and of the two compartments. The scale is marked from 30°–50°, and subdivided into tenths of a degree in such a way that each division is 1 mm. distant from the next.

A constant temperature is obtained by means of two simple Bunsen burners fed direct from the meter usually kept at half power. By raising the burner 1 cm. the temperature rises a tenth of a degree, so that to obtain the desired temperature (37°), twenty slips of wood, each 1 cm. thick, will be required. If higher temperatures are desired, the burner must be altered. The heating action of the apparatus must of course be ascertained first of all empirically, but this is only required to be done once. It may be mentioned that the course of the circulation is from the floor upwards through the central partition, then right and left along the top, and then downwards to the floor again by the short sides. The thermometers are all encased in a copper sheath, and the floor of the incubator is also made of copper.

(2) *A perfectly clear Agar Medium*, which will withstand a temperature of 40° without melting, is produced in the following manner:—Obtain the raw material, the dried *Fucus spinosus* (the ordinary agar powder is of no use), and pick out therefrom the clear yellowish transparent pieces. Then weigh the pure agar thus obtained, and wash with a 2 per cent. hydrochloric acid for five minutes, then with ordinary water frequently changed and perfectly free from dirt. By frequent weighing the quantity of water is ascertained, and by addition of concentrated bouillon the desired consistence is attained. It must be noted that for this quality of agar 5–10 per cent. is required to produce a firm medium. The agar bouillon is then left to macerate all night at the ordinary temperature. The next day it is boiled in a water-bath and strained through a linen filter. The usual quantity of pepton and common salt is then added, and after being neutralized with carbonate of potash or soda, is heated once again in the water-bath for about half an hour. The agar solution is then filtered through filter-paper. It flows through clear but slowly. On account of its rapid coagulation it is well to filter direct into sterilized test-tubes or Koch's flasks. Produced in this way the agar medium is perfectly crystal clear, remains quite firm at 40°, but is, however, somewhat softer than the ordinary solution.

(3) *Glass vessels for observing potato cultivations, &c., in various gases* may be made by expanding as much as possible the lower part of the neck of Koch's flask of about 200 grm. capacity, and then cutting them off at the middle of the neck. To the upper somewhat conical end an air-tight glass cap is fitted on, and to the side of the bulb a thin glass tube about 10 cm. long is melted in. The latter tube is intended to communicate with the air-pump. The raw potato discs are pushed through the neck opening by removing the glass cap, and after the side tube is plugged with cotton-wool the flask is sterilized. The medium having been inoculated while the flask is held in the oblique position, the air-pump is connected with the side tube; the air is withdrawn and replaced with the desired gas. When full the side tube is melted up with a Bunsen burner. In case the access of impurities should be feared during inoculation, a narrow glass tube terminated by a small cap can be fitted to the larger cap, and then inoculation may be performed in a current of the gas selected by quickly removing the smaller cover. Absolute safety is attained by closing the rims with vaselin. The tap connecting with the air-valve must be triply perforated, so that the

closure of the air-pump is simultaneous with the opening of the gasometer. It is of course obvious that experiments with this apparatus can only be made up to one atmospheric pressure.

Cultivation of Bacteria on Coloured Nutrient Media.—Prof. A. v. Rozsahegyi has experimented with the following Bacteria in order to ascertain the effect of cultivation in coloured nutrient media, and the influence of the dye on their growth, and to acquire, if possible, a new criterion for the differential diagnosis of the various species:—(1) bacilli of blue milk and green pus; (2) bacilli of rabbit septicæmia and fowl cholera; (3) bacilli of mouse septicæmia and swine plague; (4) the Koch and Finkler-Prior comma bacilli.

The gelatin was stained with various anilin dyes, prepared in the manner used for staining cover-glass preparations, and with "Tinctura Kermesina" (cochineal). A few drops of the stain were added to a small flask of liquefied 5 per cent. gelatin, some of which was filtered into test-tubes and sterilized by steam. When set, the gelatin was deeply stained, but quite clear and transparent. The cultivations were made at a temperature of about 20° C., the ordinary temperature of a room.

In the result, it was found that in certain cases it was evident to the naked eye that the dye was taken up very freely (e. g. Finkler-Prior comma bacillus in methyl-violet), and the bacilli seemed very deeply stained; yet on microscopical examination they appeared so pale that no advantage accrued from the method of staining. The influence of the dye on the growth of the bacteria was very various, although the alkaline reaction of the gelatin was unchanged by the addition of the reagent. Vesuvin was the most active preventive of growth, and less so gentian, methyl-violet, and Tinctura Kermesina. The impairment of growth was most noticeable in the liquefying varieties, and the form of the liquefaction area was also altered; thus the Finkler-Prior comma bacillus, instead of growing quickly down along the inoculation track, spread downwards in a broad channel, presenting the appearance of a cultivation of Koch's comma bacillus. In the latter the characteristic air-bubble was usually scarcely visible. In the non-liquefying varieties, the surface growth only was as a rule impaired.

In most cases the colouring matter was unaffected by non-liquefying bacteria, and where a change was observed, this began at the bottom of the cultivation; the matter causing this decoloration must therefore be produced in the absence of air. Of the liquefying comma bacilli, Finkler's had no effect on methyl-violet, while both this and Koch's comma bacillus decolorized fuchsin in the fluid part, and methylen-blue in the solid. With methylen-blue the colour could be restored on shaking, the effect lasting in a cultivation of Koch's bacillus for days, but in one of Finkler's a few hours only.

With regard to distinguishing between very similar kinds of bacteria, the author found that rabbit septicæmia did not grow in gentian, but very strongly in vesuvin. Fowl cholera grew well in gentian, but not in vesuvin. Mouse septicæmia grew strongly in methylen-blue; swine plague very poorly. Cultivations of the Finkler-Prior and Koch's comma bacilli in fuchsin appeared pretty different; in methylen-blue the former lost colour more rapidly, and while it grew well, though slowly in methyl-violet, Koch's bacillus would not grow at all.

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 418–24.

(2) Preparing Objects.

Preparing Supra-œsophageal Ganglia of Orthoptera.*—Signor G. Cuccato snips off the head of the insect with a pair of scissors, and pins it on cork. Thus fixed, the head is immersed in 0·75 per cent. NaCl solution. Then with the aid of scissors and forceps, the chitinous sheath, and the eyes, are removed from the supra-œsophageal ganglion, and the specimen removed to a watch-glass full of salt solution, wherein the tracheæ and muscles are removed. After a short time the object is placed for forty-eight hours in Flemming's mixture, and then having been well washed, the rest of the muscles and the fat are removed from the ganglion. It is next put in 36 per cent. spirit, and gradually hardened. After dehydration it is imbedded in paraffin. The sections were fixed down by Mayer's method, and stained with a saturated watery solution of acid fuchsin. The fixative used was Rabl's solution (chromo-formic acid and platinum chloride).

Treatment of Acari.†—Dr. C. Nörner remarks that Acaridæ should be treated according to their species and habitat. Such as live within a tissue, e.g. the *Acarus scabiei*, are best obtained by softening the scabs in a 10 per cent. potash solution for an hour, or perhaps better by allowing a weaker solution to act for a longer time. Very good results are produced by soaking the scabs for a day in a dilute mixture of potash, glycerin, water, and spirit. The mites are thereby rendered not too transparent and preserve their form well. A very good preserving fluid consists of equal parts of 90 per cent. spirit, glycerin, and water. When the scabs are sufficiently softened, they are teased out in dilute glycerin under a dissecting Microscope and all extraneous matter removed. Glycerin preparations may be ringed round with turpentine, with red sealing-wax dissolved in absolute alcohol or with gold size, &c. A good preparation should contain mites in all stages of development, that is to say, eggs, larva, nympha, male and female, and if possible the stage of exuviation. For such slides glycerin jelly is a better mount than glycerin. The free-living mites and ticks which infest the surface of their host are more easily obtained than the pit-digging itch insect. The feather ticks of birds are almost as numerous as the species of birds. These are obtained by laying feathers under a dissecting Microscope and removing the animals with the needles; the breast feathers of small birds require to be placed in a dilute potash solution from which they are picked out under the Microscope. The histological structure of the Acaridæ is best studied in the living animal immersed in a drop of oil, glycerin, or water. The author has also used a mixture of glycerin, spirit, acetic acid and eosin, where these reagents were extremely dilute. To prevent the animals from being crushed during the microscopical examination it is only necessary to support the cover-glass on two others.

Very pretty pictures may be obtained by staining: for his purposes Ranvier's picrocarmine is the most generally useful. Other staining fluids recommended are (1) a mixture of equal parts of picrocarmine and indigo-carmine, (2) eosin either in alcoholic solution or watery, to which 1/3 glycerin is added; (3) methyl-green; (4) ammonia-carmine; (5) Magdala red. Rosanilin and fuchsin are the most suitable for the cast-off skin. With regard to their receptivity for dyes it should be borne in mind that mites are very uncertain, some taking up none or with great difficulty, while

* Cuccato, G., 'Sulla struttura del ganglio sopra-esofageo di alcuni ortotteri,' Bologna, 1887.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 159–67.

others take up too much. Haller recommends boiling the mites, &c., in a mixture of aq. dest. and potash (2 : 1) and then mounting the chitinous framework of the head in glycerin slightly dilute, while Ehlers treated them with ammonia and oil of cloves, but the author had no success with either of these methods.

The structure of the tracheæ is best shown by slight staining with picrocarmine, illuminated by Abbe's condenser with central stop.

Sections of stained mites and ticks are prepared by immersing them in gelatin and hardening in alcohol. They are then imbedded in elder pith and so sectioned. Ova should be examined in dilute salt solution (glycerin swells their capsule too much) and without a cover-glass. Picrocarmine stains ova very well and clearly brings out the segmentation, which if unstained and in glycerin does not appear.

Preparation of Microscopical Parasites.*—Dr. Stoss obtains his preparations of Acaridæ by scraping off the scabs from the diseased animal and softening them in a 10 per cent. potash solution for half an hour. A little piece of the softened scab is then mixed with a drop of water and examined carefully under a low power (× 90). A suitable *Acarus* having been discovered, it is removed from the action of the potash solution by pushing the slide to the right and the cover-glass to the left with a needle. The *Acarus* is then freed from all extraneous objects and left on the slide for mounting, or is transferred to a watchglass containing glycerin by means of a needle. The fluid, which is suitable for extracting the potash lye, for preventing the *Acarus* from drying, or for preserving the animal, consists of a mixture of equal parts of 90 per cent. spirit, glycerin, and water. The *Acarus*, immersed in a drop of this fluid, is sealed up with a rim of wax, paraffin, or asphalt run round the cover-glass, but dammar or Canada balsam dissolved in chloroform or xylol are probably better and more durable.

When the *Acari* exist in quantity among the scabs and scales, and there is no difficulty in obtaining a good specimen, as, for example, is usually the case in cat's mange, the following procedure is recommended:—The scales are put for some time in the potash solution, and are then washed in distilled water several times. The *Acari* and scales are allowed to settle at the bottom of the vessel, and the supernatant fluid decanted off. The glycerin-spirit mixture is then poured over them, and in this they may be kept for an indefinite period without undergoing any change.

Psorosperms are well preserved in the glycerin-spirit mixture, but the proportions are different (1—1—2 water). And it is noticeable that different objects require slight alterations in the quantities of the constituents in order to produce an equilibrium between the contracting action of the spirit and the swelling action of the glycerin. Thus *Oxyuris mastigodes* remains quite intact in a fluid of 1—1—2, while *Filaria* shows fine surface-creasings, which do not appear with a little more water.

Although these parasites keep very well by the foregoing methods, they are extremely susceptible of mechanical injury. Damage from this cause is avoided by mounting in glycerin jelly. This medium is produced by softening gelatin by leaving it all night in water. It is then cut up and fluidified in a water-bath without the addition of water, and mixed with 10 per cent. glycerin and 1 per cent. carbolic acid. When cold the mass is cut up and kept in stoppered bottles. A mite or tick is mounted by placing small bits round it on a slide and then warming gently over a

* Deutsche Zeitschr. f. Thiermed. u. Vergl. Pathol., xii. (1887) pp. 202–5.

spirit-lamp. When the jelly is melted a warm cover-glass is imposed. If the mass should swell up over the cover-glass, it is easily removed when cold.

Investigation of Histology of Eunice.*—Prof. E. Jourdan reports that the use of alcohol at 90 per cent. has always given him the worst results with Annelids, and that the same has been the case with picric acid; when either of these reagents has been used the elements of the tissues are quite beyond recognition. The use of 2 per cent, solution of bichromate of ammonia, of bichloride of mercury, either saturated, as Lang's solution, or in a 5 per cent. solution, was more successful. Osmic acid (1 in 200 parts) was the best reagent for the study of the antennæ and the delicate organs in general, and was always regarded as a good means of control for observations made after the use of other reagents. After the use of these fixing solutions, the specimens were washed and then placed in alcohol of increasing degrees of strength up to 90 per cent. The alum-carmine solution of Grenacher was most used in staining. Celloidin was used at the commencement of the research, but was not found to present any advantage over paraffin; the mixture of Schällibaum was found excellent in fixing the pieces after placing in paraffin, and they were thus completely coloured. The plates carrying the series of sections were treated with various strengths of alcohol, dehydrated by absolute alcohol, and mounted in Canada balsam.

Prof. Jourdan found greater difficulty in his teasings; the most successful method was one which has been used to isolate the nerve-tubes of Vertebrates. Fresh pieces were treated with one-hundredth solution of osmic acid, and were then allowed to macerate in weak alcohol or even distilled water. Specimens preserved for a year in bichromate of ammonia were also successfully teased in a drop of hæmatoxylic glycerin, to which a drop of glycerin was added for examination and preservation.

Preparing Epithelia of Actiniæ.†—Dr. J. H. List used the tentacles of *Anthea cereus* and *Sagartia parasitica* in his examination of the epithelia of Actiniæ. The tentacles were snipped off in the vessels in which the animals were kept alive, and when the contraction due to the irritation had passed off, the greater part of the sea-water was removed with a pipette, only so much being left as would serve to keep the specimen moist. The tissue of the tentacles was then fixed with chrom-osmium acetic acid. This was allowed to act for ten minutes; the specimen was then washed, and after-hardened in spirit.

Isolation of the elements was effected by placing the tentacles in a vessel containing 100 ccm. sea-water and 30 ccm. Flemming's fluid (chrom-osmium acetic acid mixture). After allowing this to act for ten minutes, the tentacles were transferred to a large quantity of 0·2 per cent. acetic acid, wherein they remained for two to three hours. The specimens thus treated were afterwards placed in glycerin and water (equal volumes), and there teased out. Excellent isolation-preparations of the cells of the ectoderm were thus obtained; these kept extremely well, and further differentiation was obtained by staining with picrocarmine.

Breaking up Diatomaceous Rocks.‡—M. Guinard breaks up diatomaceous rocks by putting small fragments in a test-tube and covering them for about 2 cm. with crystals of commercial acetate of soda and then adding one or two drops of water. (On a larger scale the proportion of water is

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 239–42.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 210–1.
‡ Bull. Soc. Belg. Micr., xiii. (1887) pp. 180–2.

5 ccm. to 100 of the salt.) The test-tube is then placed in a water-bath, and the contents dissolved at boiling-point. It is left for ten minutes in the hot water and then removed and allowed to cool gradually, or it may be cooled rapidly by plunging it in cold water. A small crystal of soda acetate is then dropped in, when, owing to its supersaturation, it at once crystallizes. By repeating this two or three times the rock is quite reduced to powder. However, very refractory rocks, such as those from Jutland, require five or six repetitions. The next step merely consists in adding water to excess to dissolve out the salt. Another substance, the hyposulphite of soda, may be used for the same purpose. The hyposulphite of soda and some bits of rocks are mixed up in a test-tube and heated in a water-bath to 48°. The salt deliquesces, and then having been allowed to cool, a small crystal is dropped in. Water is then added in excess to dissolve out the salt. Of course the operation must be repeated until the rock is properly pulverized.

The foregoing methods, the first of which is preferred by the author, are simpler than the sulphate of soda method of Brun.

HUEPPE, F.—**Cover-glass Preparations in Bacteriological Investigations.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 190–4, from Hueppe's 'Methods of Bacteriological Investigation,' *transl.* by Dr. H. M. Biggs (New York).

JAMES, F. L.—**Preparing Crystals of Salicine.**—Referring to the note at p. 507, Dr. F. L. James further writes:—

"When, some months ago, I made note of the fact that I had hit upon the method of reduplicating the astonishingly beautiful slides of salicine accidentally made some years ago, I had little idea of the possibilities of that alkaloid in the way of strange and gorgeous groupings. Some of my later experiments in this direction have resulted in slides utterly throwing into the shade all former successes. The human eye never before dwelt on so wonderful and gorgeous phenomena as are presented in some of these latest slides. All laws and rules of crystallization seem to be set aside, and the material runs riot in its bewildering forms and combinations. The most beautiful auroras and most brilliant pyrotechnics fade into insignificance alongside some of the latest results."
St. Louis Med. and Surg. Journ., LIII. (1887) pp. 166–7.

QUIMBY, B. F.—**Insect Preparation.** II.
[Mounting—mounting insects as opaque objects.]
Microscope, VII. (1887) pp. 266–9.

(3) Cutting, including Imbedding.

Myrtle Wax Imbedding Process.*—Myrtle wax, or bayberry tallow, writes Mr. J. W. Blackburn, is a substance derived from *Myrica cerifera*. The wax is found covering the fruit as a whitish coat, and is separated by boiling the berries in water and removing the wax on cooling. It is of a pale greyish-green colour, somewhat diaphanous, brittle, slightly unctuous to the touch, is feebly aromatic, and a little bitter to the taste. Its specific gravity is about that of water, and its melting-point 46°·6 C.–48°·8 C. (116°–120° F.). It is insoluble in water, scarcely soluble in cold alcohol, soluble except about 13 per cent. in 20 parts boiling alcohol, which deposits the greater part of it on cooling. It is also soluble in boiling ether, and slightly so in oil of turpentine. It is very soluble in chloroform benzol and xylol. The foregoing account is descriptive of the true product of *Myrica cerifera*, but for the purposes of the microtomist it will not answer. A variety must be obtained which is yellowish-white in colour, tougher and softer. This variety is probably the product of *Rhus succedanea* Ln., and should be called "Japan wax."

Dr. M. N. Miller, who first described this method,† states that "bayberry tallow is firm and solid at ordinary temperature, and is solid in warm alcohol." He states that specimens may be removed from the alcohol in

* Amer. Mon. Micr. Journ., viii. (1887) pp. 164–5.
† N. York. Med. Record, xxvii. (1885) p. 429.

which they have been preserved, and placed at once in a bath of melted wax; but the author thinks it is better to first dehydrate in absolute alcohol, and then place in a preliminary bath of wax dissolved in chloroform. Benzol and xylol will dissolve large quantities of the wax, but it is deposited in a granular form on their evaporation; but after solution in chloroform the wax is left in a solid form. Hence chloroform is preferred as a solvent for the preparatory bath, but for all other purposes the less expensive reagents may be used. The chloroform may be used over and over again, and if occasionally a little fresh be added to it, the bath may be kept always ready.

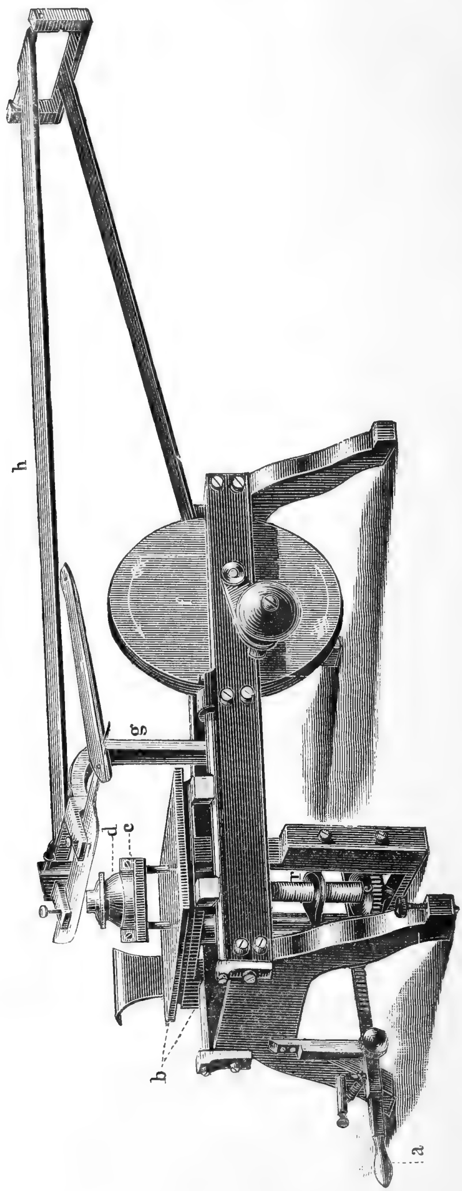
The method of using myrtle wax is as follows:—The specimens are dehydrated in absolute alcohol and then placed in a solution of wax in chloroform as a preliminary bath, or transferred directly to the melted wax. The pieces will be infiltrated in about the same time required by the paraffin method. The pieces may be fastened on cork, by using the melted wax, or imbedded in blocks of wax or paraffin to support the specimen in the clamp of the microtome. The sections are cut dry into benzol, washed in alcohol, stained and mounted as usual. To completely remove the wax, it is best to take the sections through a second bath of benzol, as any remaining wax will be precipitated by the alcohol used in the washing. Warm absolute alcohol may be used to free the sections from wax, but the benzol is better and cheaper. Ordinary alcohol warmed will not dissolve the wax perfectly. Warmed absolute alcohol will dissolve most of it, but will deposit it on cooling. The author therefore thinks that the above method is preferable to the immediate transferring from the preserving alcohol to the wax-bath, as advised by Dr. Miller. The method is more rapid than the paraffin or celloidin process; there is very little if any shrinkage; it does not injure the most delicate tissues; and it is inexpensive. If hardened in large masses there is slight shrinkage and a tendency to crack; this may be prevented by the addition of a small amount of paraffin, with which it is miscible in all proportions. The author states that he has never seen a section injured by cracking.

De Groot's Automatic Microtome.*—Herr J. G. de Groot's instrument (fig. 248) consists of a rectangular frame, supported on four feet. To the long sides of this frame are fitted two cylindrical bars, upon which the object-carrier slides. The latter is a metal plate *b* faced with ebonite, and supported on the slide rails by four feet: on its under side are two vertical bars, joined at their ends by a cross-piece, from the centre of which uprises a thick screw, and this latter passes through a threaded ring *r*. This screw-ring supports two vertical bars, the upper ends of which pass through openings in the metal plate and are then again united by a second ring. To this last is fixed a third ring *c*, which supports a cup-shaped tube *d* filled with paraffin for the reception of the object to be cut. At the lower end of the main screw is a horizontal cog-wheel *e* by the movement of which the ring *r* and with it the object-holder *d* are raised or lowered. The to-and-fro movement of the object-carrier is effected by means of a rod which connects with the large wheel *f*. The extent to which the screw is turned in the to-and-fro movement is regulated by the escapement *a*. This is a rod with rack which works up and down in a box and is fixed by a screw. When the object-carrier moves backwards, the teeth of the rack grip those of the toothed wheel *c*, so that the more they are engaged the deeper the rod is pushed in. This depth is easily determined from the figures on the rod, but it must be noticed that the hinder side of the box coincides with the

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 145–8 (1 fig.).

streaks upon which the numbers stand. When the slide is pushed forwards the toothed rod is disengaged from the wheel, and is replaced by another

Fig 248.



De Groot's Automatic Microtome.

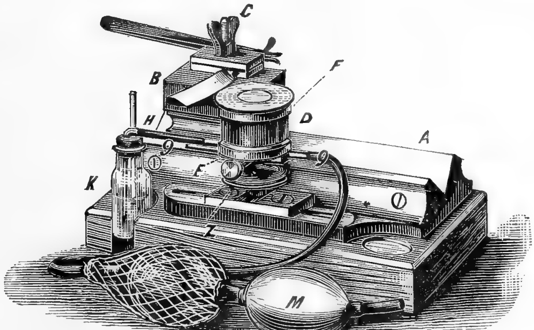
simple arrangement not shown in the illustration. The cog-wheel *e* has 150 teeth, and as one complete turn raises the object 3/4 mm., one tooth represents an ascent of 1/200 mm.

The knife-carrier *g* terminates in front in two openings, through which the knife is passed, and is there fastened by means of two screws. The cup-shaped object-holder *d* fits accurately in the ring *c*. One-half of the latter is movable and fixed by two screws, so that the preparation may be placed in any desired position. The object is imbedded in the usual manner in pure paraffin, and is then melted in the cup filled with hard paraffin. The cup is then fixed in the ring in such a manner that one surface of the paraffin mass is parallel to the knife. When cutting, each section is pushed off the knife by its predecessor, and adheres to it so that a ribbon-like strip is produced, and this is taken upon a brush and placed on the band *h*. This band moves over two rollers, one of which is attached to the front side of the microtome, the other to the knife-carrier *g*. The first section is stuck firmly to the band, the lower side of which is pulled by the left hand, so that the whole series of sections eventually lie on the upper side.

Excellent sections of the frog's embryo, and series of sections of the embryos of *Erinaceus* and *Gallus domesticus*, which are 15 mm. long, have been prepared by this instrument, which is also said to work very quickly, so that 1000 sections can be prepared in ten minutes. The fig. represents the microtome about 1/5 its natural size.

Hayes's Ether Freezing Microtome.—This instrument (fig. 249*) was designed by Dr. R. A. Hayes with the object of affording to those who have occasional need to cut sections of tissues for pathological investigations, &c., with the means of doing so quickly, conveniently, and accurately. It is

FIG. 249.



very compact, solidly constructed, and simple in plan. It freezes rapidly, and permits sections of large surface to be made with precision, sections 1 in. × 5/8 in. having been cut by it without difficulty.

It consists of a solid cast-iron base A, 10 in. × $4\frac{1}{2}$ in., which rests upon a mahogany block. Extending the whole length of the upper surface of the base is a V-shaped gutter, on the planed sides of which slides a heavy metal block B, on the flat top of which the razor is secured (any ordinary razor can be used), the tang being grasped between two flat pieces of iron, which are pressed together by a winged nut C. The razor by this arrangement can be secured at any desired angle to the direction of its motion to and fro.

The freezing chamber is formed by a short vulcanite cylinder D, its

* The block is supplied by the author, but hardly does justice to the apparatus.

lower end being screwed into a brass base E. To its upper end is fastened by two bayonet-catches a brass plate F, on which the tissue to be cut is placed. Inside the cylinder D, and rising from the base E, is an ordinary spray, the air and ether being supplied through tubes G and H, passing outside, through the base. There is also an opening in the floor of the chamber communicating with the tube I, to allow the overflow of ether in case of any accumulation inside the cylinder; any such overflow may be returned by the tube to the ether supply bottle K. The freezing chamber is secured to the top of the micrometer-screw arrangement Z, which is of the simplest form, but has a perfectly smooth and regular motion. The nut is divided to indicate a section 0·01 mm. in thickness, but half this thickness can be cut without difficulty.

The method of using the microtome is very simple. The slide and block D having been carefully rubbed clean and well oiled, the razor is clamped at any desired angle, the bottle K is filled with ether (good dry methylated ether answers perfectly), and the piece of tissue to be cut having been previously saturated with thick gum solution, is placed upon the plate F, and the spray which plays upon the under surface of the plate F set working by the hand-pump M; in a short time the tissue will be frozen quite through, and if a number of sections are required, an occasional stroke or two of the pump will keep the gum in proper condition for cutting. The sections are easily cut, as in other microtomes of this class, by alternate movements of the screw Z and stroke of the razor.

The instrument may also be used for cutting tissue imbedded in paraffin or other mass, the object to be cut being secured in position, either by being gently heated at its under surface and pressed on the plate F, to which it firmly adheres on cooling, or by a simple clamping arrangement, which can be substituted for the freezing-chamber. When used in this way large numbers of sections may be cut in series by attaching to the razor a light support to receive the sections as they are cut.

Paoletti's Automatic Microtome.*—Sig. E. Paoletti has invented an automatic microtome, which is said to answer perfectly. To a rectangular vertical upright are adapted two guides, between which the object-carrier moves vertically. The carrier is fitted with a clamp, movable in all directions. A micrometer screw, to which is fixed a toothed wheel, moves the carrier vertically upwards. Another wheel fixed to the upper end of a vertical plate is moved with this in a horizontal plane by a movement of rotation, which is transmitted to it by a lever. From the periphery of the wheel projects a vertical tooth, which, acting excentrically, displaces with a to-and-fro horizontal movement a knife-carrier, the level of which is a little higher than that of the clamp containing the preparation. At the lowest part of the plate is another tooth, which, as the instrument works, meets at intervals of about half the circumference the teeth of the cogwheel, and by locking with these imparts to the screw a displacement which serves to raise the object-carrier. Now in one complete turn of the plate the movement of the knife takes place in one half, the raising of the specimen in the other half. The tooth which causes the cogwheel to revolve can be approximated to or removed from the latter by a milled head, and thus displace it by a greater or less segment, according to the thickness desired to be given to the sections. According to the distance of the tooth from the cogwheel, the latter can be displaced by a fifth to a twenty-seventh of the circumference, and thus a thickness varying from 0·1 to 0·02 mm. can be given to the sections.

* Atti Soc. Tosc. Sci. Nat.—Proc. Verb., v. (1887) pp. 250–1.

BLACKBURN, J. W.—**On Methods of preparing Tissues for Microscopical Study, and Brains for Anatomical Demonstration.**

[Freezing method. Hardening agents. Interstitial imbedding. Myrtle-wax imbedding process, *supra*, p. 1048. Wax method applied to the preparation of brains for anatomical demonstration.]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 161–5.

GAY, G.—**[Home-made Microtome.]**

["The materials needed are a block of hard wood 5 in. by $3\frac{3}{8}$ in. by 2 in., a fine thumbscrew with a nut on it, a piece of glass tubing, and a glass slide cut lengthwise through the middle. Plane the top of the block perfectly true, then bore a hole, the centre of which should be $1\frac{1}{2}$ in. from the end, which the glass tube will exactly fit. Saw a strip from the bottom of the block, and fit the nut in the hole. Cement the glass tube in the hole in the large block with marine glue, allowing it to project through nearly the thickness of the glass side. Cement the glass slips on the top touching each side of the tube. Fit a block of wood $1\frac{1}{4}$ in. long, with a rivet in the bottom, so that the thumbscrew will work smoothly on it, to the glass tube. Screw the 3/8 in. strip with the notch in it to the block, and cut a notch $1\frac{1}{4}$ in. by $2\frac{1}{2}$ in. in the block to fasten it to a table, and the microtome is complete. Sections may be cut with a flat or common razor."]

Microscope, VII. (1887) p. 287.

KRYSINSKI, S.—**Beiträge zur histologischen Technik. 1. Photoxylin als Einbettungsmittel.** 2. and 3. see Staining. (Contributions to histological technique. 1. Photoxylin as an imbedding medium.)

Virchhow's Arch. f. path. Anat. u. Hist., CVIII. (1887) pp. 217–9.

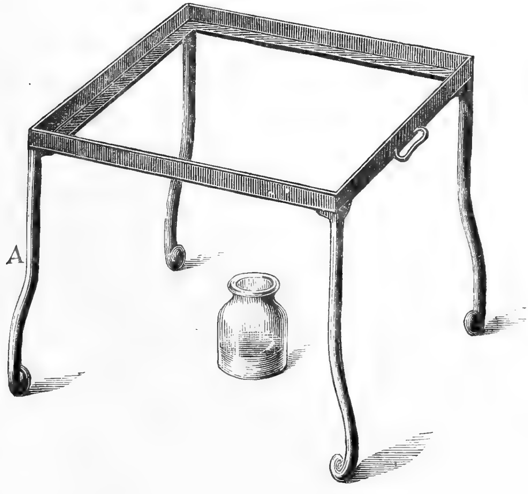
LATHAM, V. A.—**The Microscope and How to Use It. XII. Section-cutting.**

Journ. of Micr., VI. (1887) pp. 238–48.

(4) Staining and Injecting.

Perényi's Mikrolektron, for hardening, staining, and imbedding.*—Prof. J. v. Perényi has devised an apparatus, which he calls a "Mikrolektron," for facilitating the processes of hardening, staining, and imbedding without incurring the risk of damaging the preparation. Figs. 250–252

FIG. 250.

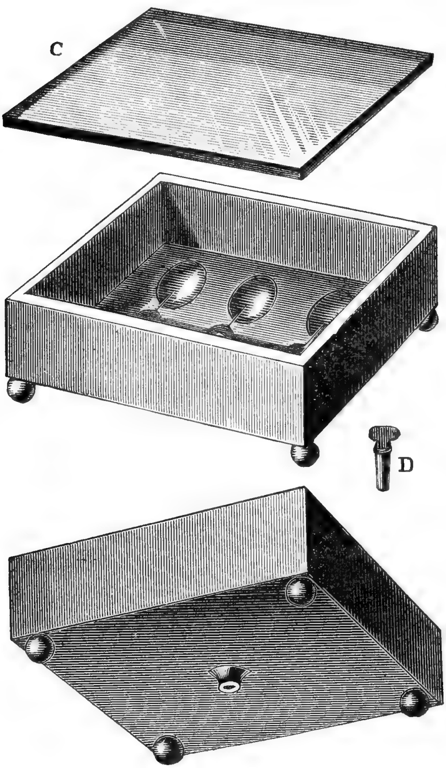


give a complete idea of the apparatus, which is nothing more than a rectangular vessel made of glazed majolica, and placed for convenience on a metal stand A (fig. 250). A dish of the size recommended, measures 16 cm.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 148–52 (3 figs.).

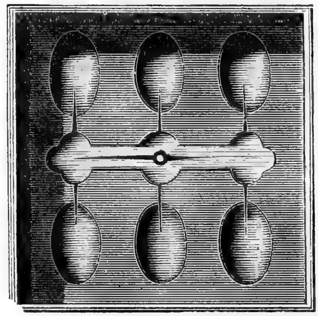
long, 16 cm. broad, and 6 cm. high, and holds 500 ccm. of fluid. On the bottom (figs. 251 and 252) are seen six oval pits, each holding 50 ccm. of fluid. These pits communicate by narrow channels with a deepish central hollow, in the middle of which is a hole, closed when the vessel is in use by a plug D (fig. 251). The dish or tray is covered with a glass top C.

Fig. 251.



The way to use this apparatus is of course obvious; the various fluids are simply poured in through a funnel, and after the necessary time are withdrawn by removing the plug D. Imbedding with paraffin is executed by putting some soft paraffin in the mid-channel, and then transferring to an incubator. When melted the paraffin finds its way into the egg-shaped pits, and thus saturates the preparation. The excess of soft paraffin having been withdrawn by removing the plug, the process is repeated with hard paraffin. It is not necessary to use an incubator, a naked flame answers the purpose. Celloidin or any other imbedding medium can be manipulated in the Mikrolektron. After using the apparatus, it is advisable to clean out the cavities and channels by the aid of heat and absolute alcohol.

Fig. 252.



Method of Staining and Fixing the Elements of Blood.*—Recent discoveries of morphological elements in the blood hitherto unknown, as well as the newly-published facts concerning its coagulation, have aroused an interest in the subject which calls for an acquaintance with the methods with which it is possible to follow those results. Accordingly, Miss Alice L. Gaule describes the method employed in the Physiological Laboratory, Zurich; for, although it has been mentioned by Prof. Gaule in his lectures for several years, it has not as yet been published.

The methods formerly used were that of examining fresh blood, and that, perfected by Ehrlich, which consisted in staining dried blood.

* Amer. Natural., xxi. (1887) pp. 677–83.

The new method consists in a series of manipulations requiring only thirty-five minutes for their completion. The following is a list of the reagents, together with the length of time and the order in which each is to be used:—

	Mins.
1. Corrosive sublimate (concentrated solution)	6
2. Distilled water	1
3. Absolute alcohol	5
4. Distilled water	1
5. Hæmatoxylin (1/2 per cent. alum solution, to which, for every 100 ccm. employed, 20 drops 5 per cent. alcoholic solution have been added)	6
6. Distilled water	1
7. Nigrosin (1/2 per cent. water solution)	1
8. Distilled water	$\frac{1}{2}$
9. Eosin (1 gr. eosin dissolved in 60 ccm. alcohol; 140 ccm. distilled water)	2
10. Alcohol	5
11. Oil of cloves	1–2
12. Xylol.	
13. Canada balsam (diluted with xylol until it readily flows).	

As receptacles for these fluids, each person has upon his table three shallow glass dishes with flat bottoms, so large that a slide may be easily put in and taken out of them. Into the first of these is poured corrosive sublimate, into the second distilled water, and into the third absolute alcohol. It is necessary either to label the dishes or to place the two not at the moment in use at one side. For the colouring fluids bottles are used whose stoppers serve at the same time as droppers or pipettes. The most convenient form is the glass stopper, which broadens into a funnel, closed by a rubber membrane. For oil of cloves, xylol, and Canada balsam wide-mouthed bottles are used. In the first two bottles are brushes; in the last, the ordinary glass rod. Other necessary utensils are a glass rod, sharp-pointed scissors, clean slides and cover-slips, filter-paper, twine or coarse thread, a small bottle of absolute alcohol, a sharp, clean needle, a fine clean rag, and a hand-towel.

Aside from these, a board, 5 by 15 in., with two pairs of holes, large enough for a piece of tape to pass through double, is an essential help. The first pair of holes should be 4 in. distant from the second, and the two holes of each pair $1\frac{1}{2}$ in. apart. The tape should be so passed through the holes that there will remain upon one side of the board loops, on the other long ends, by which, upon passing the extremities of the frog through the loops, one may easily and firmly tie the frog upon the board. Such preparation is necessary, otherwise the manipulations cannot follow one another quickly enough. After these preliminaries have been completed, the labelled bottles being placed within reaching distance, the distilled water and alcohol in front of these, and the corrosive sublimate nearest of all, we are ready to bind our frog upon the above-mentioned board and begin our preparation. We make use of the frog for this purpose at first, since its blood coagulates less quickly than that of mammals. The vena femoralis, which may be seen as a dark blue line below the knee-joint on the inner side of the leg, having been snipped, we quickly bring with a glass rod a drop of the blood which comes from the wound upon a slide previously moistened by the breath, and throw the whole into the dish of sublimate for six minutes. If a little care is taken to spread out the drop of blood in putting it on the slide, the result is more satisfactory. Brought from the sublimate into the dish of water, we find that the greater part of the blood adheres to the slide. The superfluous sublimate being washed from the preparation during the moment that it remains in the water, we next

partially dry the slide by resting it upon filter-paper before dropping it into the alcohol-bath. The slide, which has remained in alcohol six minutes, is brought again into distilled water for half a minute, since our colouring fluids are water solutions. The hæmatoxylin is then dropped upon the slide, and removed again at the end of six minutes by resting the edge of the slide upon filter-paper, and afterwards washing with distilled water for one minute. The same process follows with the nigrosin and eosin, the first remaining upon the slide for one minute, the second two minutes. From the eosin we bring the preparation directly into alcohol, since the eosin is partially an alcohol solution. At the end of five minutes the slide is taken out of the alcohol, and, in order to be quite sure that there is no water still clinging to the preparation, we incline the slide at a slight angle to the rag with which we are holding it, and pour a few drops of alcohol from the small bottle over it. If upon dropping oil of cloves on the preparation it should be dark upon a dark sleeve or other dark background, we may remove the oil of cloves with a few drops of xylol. Having quickly cleaned the slide close up to the preparation, we place a drop of Canada balsam upon it, which must be allowed to spread out before the cover-slip is lowered upon it.

Human blood is prepared in the same way, except that here the finger-tip undergoes the surgical operation.

Mitosis Staining.*—Dr. H. Zwaardemaker states that mitoses are most successfully stained by the aid of a mordant. For hardening he usually employs Flemming's chromo-osmium-acetic acid mixture, and then stains the sections with an anilin-safranin solution. This is made by pouring an alcoholic solution of safranin into about an equal volume of anilin water. In this stain the sections remain from two minutes to an hour, the exact length of time depending on the softness or the compactness of the tissue. Decoloration is performed with slightly acidulated spirit.

Colouring the Nuclei of Living Cells.†—The most interesting fact brought out in Mr. D. H. Campbell's work at Tübingen is the fact that several anilin colours have the property of colouring the nucleus of many plant cells without killing them. That the living nucleus can be stained has been demonstrated by several observers in the case of animal cells, but as far as he knows, it has not hitherto been observed in plant cells. Though the work is not yet completed, he thinks it will be interesting to give briefly some of the processes by which the results were obtained, and some of the objects employed.

The first colour used was dahlia, a violet-purple pigment, by whose aid Lavalette had succeeded in colouring living spermatozoa and the nuclei of sperm-cells. The most favourable object so far found by the author is the nucleus of the cells of stamen hairs of *Tradescantia*. *T. Virginica* was principally used, but other species gave equally good results. Hairs should be chosen from young buds, as these are perfectly colourless, not having developed the coloured cell-sap of the older hairs. The sepals and petals are removed, and the stamens thus exposed are plunged into an aqueous solution of the dahlia. After an immersion of from half an hour to three or four hours, or even much longer, depending on the strength of the solution, it will be found that in many cases the nuclei are more or less deeply coloured, and that the cell is not killed is evinced by the continuance of the protoplasmic streaming. It is quite surprising to see how deep the nucleus is often stained without killing the cell. A nucleus so coloured appears

* Zeitschr. f. Wiss. Mikr., iv. (1887) p. 212. † Bot. Gazette, xii. (1887) pp. 192–3.

perfectly normal, there being no distortion or change beyond the change in colour. As yet he has not studied especially what parts of the nucleus are coloured, but it appears to be the nucleolus and microsomes only, as in the case of cells that have first been killed and then stained according to the ordinary methods.

Among other objects that have given more or less satisfactory results were the hairs from the base of the perianth of *Lilium bulbiferum*, stamen hairs of *Aphodelus albus*, leaves of *Elodea Canadensis* and *Vallisneria spiralis*, root-hairs of *Trianea Bogatensis*, *Cucurbita Pepo*, *Tradescantia zebrina*, spermatozoids of *Chara* and a fern (probably *Blechnum*). In all cases cells were chosen in which there was evident protoplasmic movement, in order that there might be a certain means of determining whether or not the cell was still living.

Similar and usually quite as good results were also obtained with mauvein and methyl-violet, both colours closely resembling dahlia. Usually a 1 per cent. solution was made, and this diluted with from 50 to 1000 parts of water, according to circumstances. Some doubtful results were obtained with other colours, but too uncertain to warrant recording.

Absorption of Anilin Colours by Living Cells.*—Referring to Pfeffer's experiments showing that, contrary to the ordinarily accepted idea, various anilin colours can be absorbed in large quantities by living cells, Mr. D. H. Campbell calls attention to some easily made but instructive experiments bearing on the subject.

Pfeffer's experiments were mostly made with methylen-blue and methyl-violet, though numerous other colours were also tried. Among colours not employed by him, the author found that dahlia and mauvein, both very similar to methyl-violet, were quite as good, and acted much in the same way. The yellow colour chrysoidin also gave good results. No very satisfactory results were obtained with red pigments, though in some cases safranin, tropæolin, and fuchsin gave tolerably good colouring, but either it was too diffuse or the cell-wall was more deeply coloured than the contents.

With methylen-blue either the cell-sap is coloured, often very intensely, e. g. root-hairs of *Trianea Bogatensis*, or a precipitate is formed in the cell-sap, e. g. *Spirogyra*. If vesicles of tannic acid are present, as is the case in *Zygnema*, these are coloured dark blue. Methyl-violet, dahlia, and mauvein colour the protoplasm and nucleus, and are specially valuable in the study of the latter. In some cases they are also precipitated in the cell-sap. Chrysoidin appears to colour only the protoplasm. The following are some of the objects that were used:—Root-hairs of *Trianea Bogatensis*, *Cucurbita*, *Tradescantia zebrina*; stamen-hairs of various species of *Tradescantia*; *Spirogyra* spp., *Zygnema* spp.; roots of *Lemna minor*; leaves of *Elodea* (*Anacharis*) *Canadensis*, *Vallisneria spiralis*; pollen-tubes of *Hemerocallis* spp., *Tradescantia Virginica*, *Scilla* spp.; spermatozoids of *Chara*.

The objects are placed in a solution of 0·002–0·001 per cent., varying with the nature of the cell-wall and the time of immersion. Root-hairs are usually especially delicate, and the solution should be very dilute or the immersion very brief.

In most cases objects were selected where there was marked protoplasmic streaming, as this is the best means of determining whether the cell is alive or not. It is surprising how deeply the protoplasm or nucleus may be stained without materially affecting the streaming. For a demonstration of the staining of the protoplasm the root-hairs of *Trianea* were found to be

* Bot. Gazette, xii. (1887) pp. 193–4.

specially favourable, on account of their large size and the rapid streaming, as well as the readiness with which the colour is absorbed.

Staining Pathogenic Bacteria with Anilin Dyes.*— Dr. C. Günther, when dealing with pathogenic bacteria, usually employs Ehrlich's anilin-gentian solution, Löffler's potassium methylen-blue and Ziehl's carbolic-acid fuchsin solution. Dry preparations stain better if before staining they are washed with 1–5 per cent. acetic acid, and, if they have been kept unstained for a long time, with a 2–3 per cent. watery pepsin solution.

The author discusses Koch's method for staining tubercle bacilli with the improvements of Ehrlich and Rindefleisch, and recommends the Ehrlich procedure as the best and safest in practice. Gram's method is advised for the pneumonia cocci of Friedländer and Fränkel, for the cocci of pyæmia and erysipelas, for the bacilli of anthrax, lepra, and tubercle, and for actinomyces. On the other hand, Gram's treatment is quite unsuited for gonococci, bacillus of typhus, of glanders and of cholera, and also for the spirochæte of recurrent fever. For preparations which have been a long time in bad spirit and which resist decoloration by Gram's method, the following modification is recommended:—Stain the sections for 1 minute, dry with blotting-paper; decolorize for 2 minutes in the iodide-iodine solution, then 1/2 minute in spirit, then 10 sec. in 3 per cent. hydrochloric acid alcohol, after this the sections are transferred to spirit. An inconvenience appertaining to Gram's method, in the deep-staining of minute fat-globules, is best avoided by treating the specimen before it is stained with chloroform, and then washing with absolute alcohol. In order that the sections may be well stained it is advisable that not more than two or three should be manipulated at a time, as decoloration is often difficult. For double staining, the author recommends the ordinary nuclear stains for contrasting with the stain of the micro-organisms. For erysipelas sections stained by Gram's method, a double stain is best effected by previously using ammonia-carmine or picrocarmine, a procedure which will be found more suitable than after-staining. The preparations are best mounted in xylol balsam; and decoloration of tubercle and lepra bacilli, both in sections and in cover-glasses, is most perfectly avoided by the dry method as recommended by Unna.

Staining the Bacillus of Glanders.†—Dr. G. M. Sternberg says that these bacilli are best stained with a concentrated alkaline solution of methylen-blue. For staining the bacilli in sections of tissue containing them, Löffler recommends that they be immersed in the above-mentioned solution for 12 to 24 hours, and then very carefully treated with very dilute acetic acid until the sections have been decolorized sufficiently to bring the bacilli into view. After this treatment they should be washed in alcohol, and immersed in oil of cedar, which does not dissolve the anilin colours, and is therefore to be preferred to oil of cloves in all preparations in which these colours are used for staining bacteria.

Anilin Stains.‡—Dr. S. Griesbach's experiments on the anilin dyes lead him to the conclusion that between the constituents of the dyes and those of the tissues direct chemical combinations according to the laws of affinity are effected, and therefore all those forces which have a promoting, retarding, or destructive influence on affinity play a part in the staining process, while above all influences is the capacity for a saturation of the tissues with free gases, or, as Ehrlich expresses it, the gas saturation. The intro-

* Deutsche Med. Wochenschr., 1887, No. 22.
† Microscope, vii. (1887) p. 309, from Med. News.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 358–85.

ductory remarks close with a reference to the so-called mordants, the effect and use of which is well known. The author believes that for microscopical research such aids are of little or no value for staining purposes, as much of what is afterwards seen and described in the preparation must be ascribed to structural alterations due to the action of the mordants.

After enumerating the various anilin dyes, the classification of which is adopted from Hummel,* the author proceeds to discuss the characters and staining properties of Congo red and benzo-purpurin. Congo red is soluble in water, the solution being bromide-red. The specific gravity of the commercial article is 2·2149. The reaction of the chemically pure preparation is neutral, that of the trade preparation alkaline. To obtain this pure article the dye is dissolved in about 20 parts water, and is then precipitated by the aid of heat with an equal volume of saturated salt solution. After cooling, the dye is washed off the filter with the salt solution. The least quantity of a free acid turns the Congo solution blue, hence Congo is a delicate test for a free acid. This double action has been turned to account for demonstrating the presence of free acids in certain animals, and the alkaline reaction of the living tissue in others. According to the author, the watery solution of Congo is alone suitable for microscopical purposes, for, although miscible with glycerin and turpentine oil, the results therefrom are not satisfactory. For tissue staining, a concentrated watery solution stains both fresh and preserved material. Blood-corpuscles must be dried at 80° for twelve hours before using the watery solution, otherwise the action of the dye quite destroys the tissue. With regard to the staining of animal tissue generally, it appears that the plasma takes up the stain more freely than the nuclei, which are frequently devoid of colour. The hue varies from yellow to red, and preserved material stains better than fresh. One interesting example of its action is that of a section of a fibroneuroma, in which the connective tissue became of a dark orange, and the nervous tissue received a bright-orange stain. Transverse sections of nerves only stained in the sheaths, the axis-cylinder being unaffected.

Benzo-purpurin is obtainable in two shades, 1 B and 4 B. It is soluble in water, and has approximately the same hue as Congo, but is not affected by acids in the same way as Congo. Its reaction is neutral. Cover-glass preparations dried for ten hours at 200° are said to be successful. In general the stain is somewhat similar to that of Congo, but as a rule the hue is redder.

Rosanilin and Pararosanilin.†—Dr. P. G. Unna has tried to solve the question whether the appearance of lepra bacillus as threads containing cocci is dependent on the Lutz procedure, a combination of Gram's method with decoloration in nitric acid; whether this special appearance is due to a reaction between the gentian-violet and iodine, and how this peculiarity can be explained.

After numerous experiments with various chemically pure dyes the author discovered that only the pararosanilins, to which gentian-violet belongs, possess the property (when used as stated) of showing lepra bacilli as "coccothrix," while rosanilin, under similar circumstances, presented the same micro-organisms as bacilli. This difference is so constant that by their aid it is always possible under the Microscope to distinguish the two dyes, and this is all the more striking, as between rosanilin and pararosanilin there is only a slight chemical difference, CH_3 replacing H.

The author, furthermore, showed the relation of the iodine preparation

* 'The Dyeing of Textile Fabrics,' London, 1885.
† Dermatol. Studien, 1887, Heft iv., 73 pp.

to these dyes, finding that only between the combinations of simple iodine with rosanilin on the one part, and with the pararosanilin on the other part, do the characteristic differences in the staining of the lepra bacillus exist.

He suspects, therefore, that the iodine in pararosanilin staining completely extracts the dye where it is more loosely associated with the tissue, and where the combination is stronger it unites with it in the tissue. A new dye is therefore formed, which, on account of its slow and difficult extraction, is more suitable to show further differences of the tissues than the simple dye. The methods of Gram, Lutz, and Unna are accordingly to be considered as variations of a general iodine-pararosanilin method.

Extract of Logwood as a substitute for pure Hæmatoxylin.*—Dr. J. Paneth finds that the commercial extract of logwood is a satisfactory substitute for pure hæmatoxylin in staining the central nervous system after Weigert's method. From this extract is made a solution which contains 90 parts water, 10 parts spirit, 1 part dye. Before use it is filtered. To 100 ccm. of this solution 8 drops of a concentrated solution of lithium carbonate are added. The celloidin-imbedded sections are placed for twenty-four hours in Weigert's copper acetate solution, then in 80 per cent. spirit; then are stained in the above solution for 18–24 hours at the ordinary temperature. They are next decolorized with the borax and ferro-cyanide solution.

This method, which is practically that of Weigert, gives similar results, but at a much less cost.

Reduction of Chromic Solutions in Animal Tissues corrected by Reoxidation with H_2O_2.†—It is well known that the brownish-green colour assumed by animal tissues under exposure to chromic solutions is due to a combination of the oxide of chromium (Cr_2O_3) with CrO_3. There is a partial reduction of the chromic acid in the tissues, resulting in the formation of Cr_2O_3, which then unites with the remaining CrO_3 to form the compound known as chromic chromate. Dr. P. G. Unna has shown that the greenish colour can be removed by treating the tissues with hydrogen dioxide.

The chemical processes involved are explained in the following manner:—If a solution of chromic acid or bichromate of potassium be mixed with a solution of H_2O_2, a deep green precipitate of chromoxide (Cr_2O_3) is immediately formed, which combines with the remaining chromic acid to form the intermediate salt (chromic chromate) with a brownish-green colour. If the mixture is left to itself, the process of reduction, after reaching a definite point, changes to one of oxidation, and the chromic chromate is soon reoxidized, leaving the solution yellow as at first. The same phenomenon is seen when (1) sections coloured by chromic acid or bichromate of potassium are placed in H_2O_2, or when (2) sections treated with H_2O_2 are immersed in the chromic solutions. The sections at once become dark green, then brownish-green, and finally, in the first case yellow, in the second colourless. If the sections, at the moment when the brownish-green colour appears, are removed from the solution and thoroughly washed, the colour of the chromic chromate, which is not unimportant for many histological details, remains fixed.

BABES.—**Nouvelle coloration des tissus normaux et pathologiques.** (New stain for normal and pathological tissues.) *Bull. Soc. Anat. Paris,* XI. (1886) p. 73.

HAUSER, G.—**Zur Sporenfärbung.** (On spore-staining.) *Münch. Med. Wochenschr.*, 1887, p. 654.

JOSEPH, M., and C. WURSTER.—**Über der Metaphenyldiamin als Kernfärbemittel.** (On metaphenyldiamin as a staining agent for the nucleus.) *Monatschr. f. prakt. Dermatol.*, 1887, Nr. 6.

* Zeitschr. f. Wiss. Mikr., iv. (1887) p. 213.

† Arch. f. Mikr. Anat., xxx. (1887) p. 47. Cf. Amer. Natural., xxii. (1887) p. 868.

KRYSINSKI, S.—**Beiträge zur histologischen Technik.** 1. See Imbedding. **2. Indigo-carmin als Tinctionsmittel. 3. Alauncarmin.** (Contributions to histological technique. 2. Indigo carmine as a staining agent. 3. Alum carmine.)
Virchow's Arch. f. path. Anat. u. Hist., CVIII. (1887) pp. 217–9.

WEIGERT, C.—**Über eine neue Methode zur Färbung von Fibrin und von Microorganismen.** (On a new method of staining fibrin and micro-organisms.)
5 pp., 8vo, Berlin, 1887.

(5) Mounting, including Slides, Preservative Fluids, &c.

Mounting Sections without Cover-glasses.*—Dr. C. Weigert recently showed that celloidin sections could be cleared up with carbol xylol, and as many of these sections were intended to be mounted under the same cover-glass it was found in practice to be somewhat expensive to provide cover-glasses of sufficient size. He resolved to follow in Golgi's footsteps, and do without the cover-glass, but as the Italian method has several inconveniences attached to it he adopted the photographic negative varnish as the substitute for dammar.

After the sections have been cleared up with carbol xylol, the excess of fluid is removed in the usual way with blotting-paper, and a thin layer of the negative varnish is poured on. This dries very quickly. The drying may be accelerated by gently warming the slide, and this must always be done if the layer appears cloudy. When the first layer is dry, another coat is laid on, and so on until the surface remains quite smooth. Three coats are usually sufficient. When finished, the surface may, if necessary, be wiped or washed with water; high powers and even oil-immersion lenses may be used in the examination. In the latter case, a small drop of water must be placed on the surface, and upon this a cover-glass. This method cannot be used for sections stained with the anilin dyes as the carbol xylol destroys them.

Gum Dammar.†—Dr. F. L. James, referring to a paper by Mr. H. Morland‡ (in which he discredits gum dammar on the ground that it is as friable as chalk) says that he has used dammar for several years as a medium for mounting diatoms, crystals, &c.; in fact, to the entire exclusion of Canada balsam, styrax, and all other resinous media, and with perfect satisfaction. It may be used without decolorization by proceeding as follows: Dissolve the dammar in sufficient benzol to give a fluid which will pass through the best Swedish filtering paper. When filtered, evaporate the surplus benzol, and bring the solution to the consistency of treacle. Now add to each ounce of the resultant solution ten minims of the best nut or poppy oil, and shake well. The result will be a "balsam" that will never become brittle, turn red, or become opaque.

Decolorized dammar may be made as follows: Dissolve dammar in benzol, and to the solution (which should be filtered through absorbent cotton or mineral wool) add alcohol of 95% until it no longer throws down a white precipitate. Stir thoroughly, decant the supernatant liquid, and wash the precipitate gum in absolute alcohol. Wash well, mulling the gum while washing, and afterwards rinse with water. Throw the washed gum on a filter and let dry (which it will do in twenty-four hours), after which it should be dissolved in pure benzol (*benzol purissima*, or the crystallizable benzol of Merck), and either allowed to stand a while or filtered. The solution will be as limpid and clear as crystal; but the gum contained in it is excessively friable. This defect is corrected, as in the former instance,

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 209–10.
† Engl. Mech., xlvi. (1887) pp. 184–5.
‡ Journ. Quek. Micr. Club, iii. (1887) pp. 108–14.

by the addition of nut or poppy oil. The refractive index of this gum the author has not accurately determined; but it is so nearly identical with that of crown glass that a bit of the latter substance dropped therein is visible only with the closest scrutiny.

Xylol-Dammar.*—In an article on resinous substances and the preservation of microscopical preparations, Dr. G. Martinotti advocates the use of dammar as the fittest medium for mounting microscopical preparations when the general structure is desired to be brought out. In this respect it is superior to Canada balsam which is most suited for throwing into relief certain parts of a specimen which are deeply stained, such as nuclei, micro-organisms, &c. A suitable solvent for dammar has long been a desideratum, for though Flemming and Pfitzner have produced dammar solutions with turpentine and benzin, the resulting fluids have the fatal fault of losing their transparency in a comparatively short space of time. After numerous experiments, the author finally selected xylol as the solvent, and he found it to possess the necessary qualifications. The medium he produced, xylol-turpentine-dammar, is a white or slightly yellowish fluid which does not affect the anilin stains nor dissolve celloidin, retains its transparency (for nine months at least), and gives a perfect definition of the histological elements. Finely powdered dammar resin and xylol are placed together in a closed vessel, and after some days the clear supernatant fluid decanted off, or the mixture filtered. The clear white fluid is then evaporated in a water-bath to a semi-fluid mass, which is yellowish and resembles Canada balsam. If desired, the mass may be further concentrated, and in this denser condition it does not lose its transparency or viscidity. In practice, however, it is not necessary to proceed further than the semi-fluid condition. To produce a medium suitable for microscopical purposes, oil of turpentine is added. By this addition the microscopical images are rendered more effective than with the simple xylol solution; the medium is less brittle when dry, and also loses most of its yellow colour. The author regrets this slight defect, and thinks it might be obviated if the concentration were carried out in vacuo and not by the aid of heat. In a note the author appends the exact quantities for making the solution. 40 gr. of powdered dammar resin, and 40 gr. of xylol are left for three to four days at the ordinary temperature in a closed vessel and then filtered. The filtrate is evaporated in a water-bath down to about 45 gr., and to this 25 gr. (or even more) of essence of turpentine are added.

The author next refers to some solvents of Canada balsam, chloroform, turpentine, benzin, oil of cedar, and xylol. Chloroform is objected to on account of the yellowness which increases with time. Turpentine decolorizes certain dyes, e. g. hæmatoxylin, and after a certain period bubbles of gas are developed within the preparation. Benzoin is fairly good, but the fluid is rather viscid. Of cedar oil as a solvent the author has no personal acquaintance. Xylol gives fair results, but the colour of balsam dissolved therein is markedly yellow. Safranin and other dyes seem to be injuriously affected by this reagent, which moreover is destructive of certain delicate structures, such as karyokinetic figures.

Oil of lavender produces with Canada balsam an almost colourless fluid; preparations mounted therein are said to be quite elegant, especially those stained with logwood. Some anilin stains, e. g. safranin, are however dissolved by the action of lavender oil, but others retain their brilliancy. The author, however, admits that his experience of this solvent is too short

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 153–9.

to give a definite opinion of its value, but he thinks that it will be found to be extremely useful.

Directions for using Prof. H. L. Smith's High Refractive Mounting Media.*—Prof. H. L. Smith gives the following directions:—Use barely enough of the medium to fill in under the cover when the slide is warmed; it does not materially diminish by any subsequent heating.

Boil thoroughly under the cover and until all bubbles disappear on allowing the slide to cool; if any should still remain they may be readily coaxed out by proper application of a small flame.

When the slide is cold the cover should remain firmly fixed; any excess of the medium must be removed by means of a moist cloth or a roll of moistened tissue paper. The cleansing must be thorough; all excess must be removed around the edge of the cover, as otherwise it is liable to act upon the cement or finishing ring. If, after the cleaning, the cover shows metallic stains, do not attempt to clean them off until after the finishing ring is hard. When the excess has been removed around the edge of the cover, gently warm the slide to drive off the small amount of moisture that may have been absorbed during the cleaning. When again cooled apply a protecting ring of asphalt-black, or white zinc, or, perhaps better, if one will take the trouble to make them, a wax ring, punched from the sheet-wax used for artificial flowers. The wax ring is a sure protection, especially for the highest medium, yet the white zinc or the asphalt answers well. In using the wax ring, the heat must be very cautiously applied, so as barely to melt it, following gently around with a very small flame. If bubbles of air are entangled under the ring, touch them with a heated needle-point just before the wax cools.

When the asphalt, white zinc, or wax ring is solid, apply a good coat of shellac dissolved in alcohol. Slides thus protected keep perfectly well. After the ring is firmly set, any metallic stains remaining on the cover may be removed by a piece of tissue paper and moistened with hydrochloric acid.

Section-lifters.†—Dr. W. Y. Cowl advocates the use of section-lifters made of horn. They are in one flat piece, weigh 10 grains, are 3 in. long, and 5/8 in. wide at the blade, which is square, of about 1/200 in. thick, and merging into a handle 1/20 in. thick and 3/8 in. wide. The blade is smooth, flexible as paper, and pierced with fine holes. It can thus be insinuated beneath a section lying flat on the bottom of a dish and upon removal from the surrounding fluid will allow it to drain away from between the section and lifter. This brings the two into uniform apposition, which is a great desideratum. The perforations also favour the floating of the section from the lifter to the mounting or preparatory fluid on the slide. As horn normally contains grease as well as moisture, it will take oily or gummy media, but must then be confined to use with them. Lifters for water or glycerin must be made of burnt horn, i.e. mostly deprived of fat. In preparing specimens, the lifter is preferably inverted over the slide when loaded with a section, whilst a drop of fluid let fall on the holes in the middle of the blade, loosens the tissue, from which the instrument may then easily be withdrawn. As the horn is transparent, every detail of the section on its under side can be seen.

The use of such a section-lifter naturally suggests a stout bristle instead of a needle. It may be held in a clamping needle-holder, and when so mounted, or even simply tied to a stick, will so far surpass the needle as a means of manipulation that no one who has ever tried it will cease its use.

* Microscope, vii. (1887) pp. 308–9.

† Ibid., pp. 164–6.

"Berry's Hard Finish" as a Cement and Mounting Medium.*—Prof. W. H. Seaman writes that early last winter Dr. Taylor suggested that a varnish known as Berry's hard finish (substantially Zanzibar copal dissolved in turpentine) might serve as a cement. This varnish is in very extensive use for coating wood in its natural colours, in the method now so common, and hence easily got everywhere. Dr. C. T. Caldwell took up the subject, and in the course of mounting a few slides, found he had a material which was not only useful as a cement, but also as an imbedding or mounting substance proper. Since his trials a number have used it, all with the most favourable results. Prof. Seaman has slides showing insects imbedded in it that have cleared up well without any previous preparation. Numerous other mounts have been made by other persons of different kinds, and he "has no hesitation in recommending it for trial as the most promising thing in this line he knows." It is so common it may be obtained at any paint store, and may be thinned with turpentine if too thick. One of its advantages is that it does not precipitate when brought in contact with aqueous solutions to anything like the extent that balsam does.

King's Cement.†—Under the heading "a thoroughly reliable cement," Miss M. A. Booth says that after an extended and critical experience she thinks that the cement prepared by the Rev. J. D. King possesses all the desirable qualities of a universally useful cement. To lovers of the beautiful, King's scarlet or blue cement is pleasing to the eye, while that large class of microscopists to whom such beauty is a blemish will find in his amber cement reliability shorn of any objectionable features. In every instance in which she has known where King's cements have not proved fully satisfactory the fault has been with the user.

In using Mr. King's cements, four points are to be observed:—

(1) Keep your cement of the right consistency; if too thick, thin it with alcohol.

(2) Use a Winsor and Newton Rigger brush No. 2; have its handle put through rubber cork, and keep the brush when not in use in a corked vial of alcohol.

(3) While using the brush wash it frequently in alcohol.

(4) Use no cement cells until they are *thoroughly dry.*

"Observing these precautions, we have an infallible cement."

HOLDEN, A. L.—**A New Material Cabinet.**

["A very artistic and inexpensive material cabinet can easily be constructed in the following manner:—It consists of three tin or wooden boxes, of equal height, with flat covers, varying in diameter from $1\frac{1}{2}$ to $3\frac{3}{4}$ in. Take the largest, and fasten to the bottom a circle of wood or metal, $4\frac{1}{2}$ in. in diameter and 1/2 in. in thickness. The projection will form a rest for the vials, which are held in position by a rubber band placed around each box. The next smaller box, $2\frac{3}{4}$ in. in diameter, should be fastened to the cover of the largest, and so on. The interiors of the boxes form a receptacle for packets of dry material. If painted a light colour, the objects in the vials will be easily seen, and when finished, it makes a useful ornament for the microscopist's table."]

Microscope, VII. (1887) p. 293 (1 fig.).

[MANTON, W. P., and others.]—**Elementary Department. Seventh, Eighth, and Ninth Lessons.** [Mounting media.—Sealing and cements.—Cells.—Cell-building.]

Microscope, VII. (1887) pp. 277–80, 302–4, 337–9.

(6) Miscellaneous.

Crystallization by Cold.‡—Dr. F. L. James makes geometrically perfect crystals in the following manner:—Provide two watch-glasses of nearly equal size and shape, so that they fit snugly into each other. Into one of

* Queen's Micr. Bulletin, iv. (1887) p. 33.
† Microscope, vii. (1887) pp. 297–8.
‡ Ibid., pp. 166–8.

these pour the liquid to be crystallized, and having warmed the other by passing it through the flame of the lamp or dipping it in hot water, place it immediately on the top of the globule of fluid, letting it settle to place of its own weight. The fluid is thus spread out into a tenuous film between the two watch-glasses. Now place the watch-glasses upon a piece of felt, two or three thicknesses of blotting-paper, or some other non-conducting material, and with a pipette pour on to the cavity of the upper glass a half fluid drachm of rhigoline, benzol, or ether, and blow on it with the lips. As the temperature falls the film of liquid begins to deposit crystals; sometimes this occurs instantaneously, usually it requires about fifteen seconds to a minute to thoroughly cool the glasses. If necessary, the process must be repeated.

As soon as the deposition of crystals ceases take a bit of blotting-paper and pass the edge of it between the glasses to absorb the remaining mother liquor, leaving the crystals nearly dry. The upper glass is then removed and the crystals in the lower glass may be examined at once under the Microscope or collected and washed.

It is presumed that the liquid to be crystallized is in a concentrated state: if not, the small quantity required for this process is easily thickened by placing the glass on a hot slide for a few moments. Where the operation must be repeated, it is best to use a clean glass for each portion, or to carefully remove the crystals resulting from previous refrigerations, since the second crop has a tendency to form around and on the first, thus making masses too large for convenient examination with high powers. The use of the pipette for placing the volatile fluid in the upper watch-glass is recommended, because of the difficulty of pouring small quantities of readily flowing fluids with any exactness, and the consequent danger of overflowing and mixing with the fluid to be crystallized.

Method of obtaining Methæmoglobin Crystals.*—Prof. W. D. Halliburton recommends the following easy method for obtaining methæmoglobin crystals. A few cubic centimetres of the defibrinated blood of a rat, guinea-pig, or squirrel, have added to them an equal number of drops of nitrite of amyl, and the whole is shaken vigorously in a test-tube for a minute or so. As soon as the liquid becomes chocolate-coloured a drop is placed on a slide and covered. In a few minutes crystals of methæmoglobin are formed, and if the edges of the cover-glass be sealed they may be kept unchanged for several months. From guinea-pigs' blood the crystals thus obtained are tetrahedra; from squirrels' blood they are perfectly regular hexagonal plates, as are also those from rats' blood; but in the case of the last there were a few other plates which, in the opinion of Mr. L. Fletcher, are merely variations of the hexagons.

Fearnley's 'Elementary Practical Histology.' †—This book has a feature which is extremely novel in a histological work, viz. it contains an account of the Diffraction Theory (under the head of "Immersion Lenses"), with diagrams illustrating Prof. Abbe's leading experiments. The author has been recommended ‡ to omit this portion in future editions, a recommendation which we hope he will not adopt. His reviewer, like so many histologists, has evidently not appreciated the practical importance of the discussion; but one good effect of the book will, we have no doubt, be to make many practical workers with the Microscope acquainted with one of

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 201–4.

† Fearnley, W., 'A Course of Elementary Practical Histology,' xi. and 363 pp., 46 figs. (8vo, London, 1887).

‡ Nature, xxxvi. (1887) pp. 481–2.

the most important points in connection with microscopical observation, without a knowledge of which they are continually liable to misinterpret histological structures.

ARLOING.—**Un analyseur bactériologique pour l'étude des germes de l'eau.** (A bacteriological analyser for the study of germs in water.)
CR. Soc. Biol., 1887, pp. 539–40; *Arch. de Physiol.*, 1887, pp. 273–85.

BISCHOF, G.—**Dr. R. Koch's Bacteriological Water Test.** III.
Lancet, 1887, II. pp. 516–8.

CARNELLY and T. WILSON.—**A New Method for determining Micro-organisms in Air.**
[Consists essentially in the substitution of a flat-bottomed conical flask for a Hesse's tube.]
Nature, XXXVI. (1887) p. 570; *Chem. News*, 1887, p. 145.

EVANS, J.—**Address to Middlesex Natural History and Science Society.**
["The water supplied by the companies no longer, I am glad to say, affords so varied a field for microscopical observation as it did some fifty years ago; but for microscopic studies it is doubtful whether there is not fully as much scope for students living in towns as for those who reside in the country."]
Trans. Middlesex Nat. Hist. and Sci. Soc., 1886–7, p. 7.

FABRE-DOMERGUE.—**Les Invisibles. Phénomènes les plus intéressants de la vie des êtres microscopiques.** (The Invisibles. The most interesting phenomena in the life of microscopic beings.) 120 figs., 16mo, Paris, 1887.

HITCHCOCK, R.—**The Biological Examination of Water.** II.
Amer. Mon. Micr. Journ., VIII. (1887) pp. 169–71.

JAMES, F. L.—**Clinical Microscopical Technology.** IX. The examination of Semen.
St. Louis Med. and Surg. Journ., LIII. (1887) pp. 292–4.

PETRI, R. J.—**Ueber die Methoden der modernen Bakterienforschung.** (On the methods of modern bacteria research.)
Samml. Gemeinverständl. Wiss. Vorträge (*Virchow and Holtzendorff*), 8vo, Hamburg, 1887, 62 pp.

„ „ **Eine neue Methode, Bakterien und Pilzsporen in der Luft nachzuweisen und zu zählen.** (A new method for demonstrating and counting bacteria and fungus-spores in the air.) *Zeitschr. f. Hygiene*, III. (1887) pp. 1–145.

PEYER, A.—**Atlas der Mikroskopie am Krankenbette.** (Atlas of the microscopy of the sick-bed.) 2nd ed., xii. and 232 pp., 100 pls., 8vo, Stuttgart, 1887.

SLACK, H. J.—**Pleasant Hours with the Microscope.**
[*Actinophrys*, *Actinomonas*, &c.] *Knowledge*, XI. (1887) pp. 267–8 (4 figs.).

TAYLOR, T.—**The Crystallography of Butter and other Fats.** I., II., III.
Amer. Mon. Micr. Journ., VIII. (1887) pp. 152–3 (1 pl.), 172 (1 pl.), 190 (1 pl.).

WHITE, T. C.—**A Manual of Elementary Microscopical Manipulation for the use of Amateurs.** iii. and 104 pp., 1 pl. and 6 figs., 8vo, London, 1887.

PROCEEDINGS OF THE SOCIETY.

Meeting of 12th October, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 8th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Bonnier, G., and G. de Layens, Nouvelle Flore du Nord de la France et de la Belgique pour la détermination facile des plantes sans mots techniques. xxxiv. and 307 pp., 2282 figs., and 1 map. (8vo, Paris, n.d.)	*Prof. Gaston Bonnier.*
Chinese book on Natural History, &c., with woodcut of a Microscope	*Mr. Crisp.*
James, F. L., Elementary Microscopical Technology. Part 1, iv. and 107 pp. and 15 figs. (8vo, St. Louis, 1887)	*The Author.*
Maskell, W. M., An Account of the Insects noxious to Agriculture and Plants in New Zealand—The Scale-insects (Coccididæ). 116 pp. and 23 pls. (8vo, Wellington, 1887)	*The Author.*
Sachs, J. v., Lectures on the Physiology of Plants, translated by H. Marshall Ward, M.A., F.L.S. xiv. and 836 pp. and 455 figs. (8vo, London, 1887)	*The Publishers.*
Photomicrographs of Proboscis of Blow-fly, stained vertical section of Human Scalp, *Pulex irritans*, Liver Fluke of Sheep, Red Earth Mite, and injected Human Brain	*Mr. W. Ball.*
Patent Microtome	*Mr. H. J. Dale.*

The President welcomed Mr. C. B. Farwell, Senator for Illinois to the Congress of the United States of America, who was present with his brother, Mr. J. V. Farwell, also of Chicago.

Mr. Crisp called attention to a Chinese book on natural history, having an illustration which represented a Microscope almost identical in pattern to the one from Japan exhibited at the meeting of the Society in May last. It would be remembered that this instrument was much criticised at the time by Mr. Beck, who threw doubts upon its Oriental origin; but it was clear, from the figure given in this book, that the pattern was one recognized in the East as a typical form of Microscope. He was sorry Mr. Beck was not present, so that he might see the illustration.

Prof. M. Thury's note was read, describing a multi-ocular Microscope, which he had designed for facilitating class demonstrations. It had several body-tubes and eye-pieces, the image being thrown into each tube successively by the rotation of a total-reflection prism placed over the objective. The teacher and his pupils could thus view the same object without having to change their seats (*ante*, p. 796).

Mr. Crisp exhibited, in connection with the note, the bi-ocular and tri-ocular Microscopes of M. A. Nachet, and the quadri-ocular Microscope of Prof. Harting.

Mr. J. Mayall, jun., said that, with regard to Prof. Harting's quadri-ocular Microscope, he found that M. Nachet claimed to have made such a Microscope, and to have communicated with Prof. Harting about it in 1854. M. Nachet had recently forwarded a drawing of the particular prism which

he used for the purpose, whence it was clear that the prisms were similar in form, though apparently that of M. Nachet was much smaller than those employed by Prof. Harting, of which Mr. Crisp possessed two. M. Nachet had also sent over a prism such as he used in his tri-ocular Microscope, and it would be seen that it was a very complicated one, the construction of which would probably puzzle many persons. He had also forwarded one of his prisms used in the bi-ocular form. These prisms were submitted for the inspection of the meeting.

Mr. C. D. Ahrens' Microscope, with three body-tubes and three objectives, was exhibited by Mr. Crisp (*ante*, p. 799).

Mr. J. Mayall, jun., said that in devising this Microscope he did not think that Mr. Ahrens had any scientific end in view, his idea merely being to have something which would serve the purpose of three Microscopes in one, to exhibit to the public on festive occasions at Hampton Court and similar places.

Mr. Crisp said that since their last meeting they had had a correspondence with Dr. Van Heurck on the subject of the remarks made at the January meeting by Mr. Mayall and Mr. Beck as to the photographs of *Amphipleura pellucida* made by Dr. Van Heurck, the suggestion being that the background of the photographs had been painted out. Another set of photographs had now been sent over which had not been manipulated, and which, Dr. Van Heurck claimed, showed all he had formerly represented.

Dr. Van Heurck's letter was as follows :—

"Basing himself on what was said by Mr. Mayall at your January meeting, Dr. J. D. Cox stated, at a meeting of the New York Microscopical Society, that my photographs had undergone notable alterations.

As I cannot allow such assertions to pass uncontradicted, casting doubts on the accuracy of my observations, I have sent to New York some further prints of my photographs, duplicates of which I send to you. It will be readily seen that these have not undergone the slightest alteration.

I specially call your attention to the longitudinal lines of the *Amphipleura pellucida*, which are vastly more difficult than the beads. The undulated nature of these striæ, so different to diffraction lines, shows clearly that they are real longitudinal lines."

Mr. J. Mayall, jun., said he was sorry that Dr. Van Heurck should have objected to his criticism, but he must insist that he was fairly entitled to criticize the photographs which he saw on the previous occasion ; and when it was said that no diffraction lines were visible, he could hardly do otherwise than point out that the natural background on which they were said to be projected had been blocked out, leaving the field quite white, and consequently destroying the natural outlines of the diatoms. He considered the photographs to be excellently taken, but he objected strongly to the use of an artificial background, which gave fictitious outlines to the objects. He considered all such manipulations as seriously interfering with the scientific value of photomicrographs.

Mr. Enock's preparation of the Hessian fly, and also of its parasite (*Semiotellus destructor*) was exhibited.

Prof. Bell said of course they all devoutly hoped that the parasite might increase and multiply abundantly. The fly itself seemed of late to have been making as much stir in this country as the Colorado beetle did some years ago. It was a very important matter to know that the adult form

had been discovered in this country where they had only previously found the larva and pupa. He hoped that if any Fellow of the Society should come across this insect, he would make it his duty to bring it forward.

Mr. Swift exhibited a Microscope which, on the suggestion of Prof. Tuson, of the Royal Veterinary College, had been platinized by a new process of plating by platinum which had been lately introduced, and which, as applied to Microscopes, he considered to be a great advantage. The fittings of stages in particular are much affected by the action of corrosive fluids, but this is entirely obviated by the process in question. The square edges are not rounded off, as is the case where nickelled. The platinizing had been done by the Bright Platinum Plating Company, and, according to the manager, the cost was about that of plating with silver.

Mr. Crouch exhibited Dr. Woodhead's Microscope with unusually large stage ($11\frac{3}{4}$ in. by $9\frac{3}{4}$ in.) for examining sections through entire organs (*supra*, p. 1015).

Mr. G. M. Giles's Army Medical Microscope was exhibited, and his description of it read. The instrument was designed so as to be applicable to all the work of the military surgeon in station as well as in camp life, and at the same time to be so portable as to pack into a box 5·8 in. by 3·2 in. by 2·75 in. (*supra*, p. 1012).

Mr. Crisp said it was not usual in that room to call attention to things which might be sent for the purpose of sale; but he thought exception might very properly be made in the case of the drawings of the late Mr. Draper. These drawings had, he believed, never been surpassed, and Mr. Draper's widow would be glad to dispose of them to any Fellows of the Society.

Mr. Beck said he recollected very well these drawings of Mr. Draper, which were certainly the most beautiful he had ever seen. He should, therefore, be glad if by some exercise of their discretion the Council could secure them for the Society. Original drawings had always a special value of their own, and he thought the matter might be referred to the Council to consider whether they could be acquired. In all such cases, where a diligent observer had acquired a power of delineation such as that possessed by Mr. Draper, it was desirable that examples of the results should be in the possession of the Society. He would, therefore, submit to the meeting a motion to the effect that the Council be asked to take the matter into their consideration.

Mr. Deby seconded the motion, and said that in order to assist in carrying out the suggestion, he would be prepared to subscribe to a fund for the purpose.

The President having put the motion to the meeting, declared it to be carried unanimously.

Mr. Deby called attention to the sixth annual report of the United States Geological Survey, dated 1885, but only just distributed, which contains a valuable article by Mr. J. S. Curtis, on the 'Quantitative Determination of Silver by means of the Microscope.' This method of assaying ores of silver is a very considerable improvement upon Plattner's well-known method, and has really practical applications. A new micrometer measuring apparatus is figured, and the mode of manipulation fully described.

Mr. H. J. Dale exhibited a microtome which he had made and patented, the speciality of which consisted in the arrangement for working it with the foot, so that both hands were left free for cutting the sections.

Mr. Crisp said it would be recognized as within the duty of the Society to call attention to any important misstatements in the utterances of eminent scientific men in relation to microscopical subjects, and he desired, therefore, to correct the statement of Sir Henry Roscoe in his Presidential address to the last meeting of the British Association, in which he treated the 1/100,000 of an inch as the limit of visibility with the "highest known magnifying power." The limit should be at least the 1/500,000 of an inch.

The President said that the opinion expressed by Mr. Crisp was quite in accordance with the experience of those Fellows who had worked with the higher powers. He could say that he had himself certainly seen objects which were between the 1/200,000 and 1/300,000 of an inch (*ante*, p. 827).

Col. O'Hara's further note on the 'Motion of Diatoms,' accompanying photographs of *Surirella*, was read as follows:—

"In my first communication on this subject I pointed out the means of movement possessed by *Navicula*, and in my second that possessed by *Cocconeis*. I now send an enlarged transparency on glass and an enlarged print on Eastman's paper, which illustrate that possessed by the *Surirella* form. It appears, therefore, that the means of movement which I suggested as applicable to some forms of the Diatomaceæ is probably possessed by all, viz. an undulating and extrusible membrane."

Mr. P. H. Gosse's paper on 'Twenty-four more New Species of Rotifera," all British, was brought before the meeting by **Prof. Bell**, who gave a *résumé* of its contents (*supra*, p. 861).

The President said it gave them great pleasure to receive communications such as this from time to time from Mr. Gosse, who was one of their Honorary Fellows.

Mr. C. R. Beaumont's paper, 'Observations on the Metamorphoses of *Amœbæ* and *Actinophrys*,' was read, in which he stated that he had watched *Amœbæ* change to *Actinophrys*, and the *Actinophrys* afterwards develope into *Difflugia* and *Arcella*. His observations had been made with so much care, and were so detailed and repeated, that he considered he could not be mistaken.

Prof. Bell said that in *Amœba* they had a naked mobile mass of protoplasm, apparently devoid of organs and continually changing in form; in *Actinophrys* there was an organism of definite form, and provided with a number of long, straight processes; whilst in *Difflugia* they had a regular mass of protoplasm provided with a case which it made for itself out of the débris of shell or other materials by which it happened to be surrounded. That an *Amœba* should develope into an *Actinophrys* was a fact which might or might not be proved; but it must be borne in mind that the term *Amœba* was used not only in the strict sense in which one would use the terms *Homo* or *Equus*, but as designating any of a number of similar forms. Any statement, therefore, as to *Amœba* passing into *Actinophrys* stood upon a different basis from that of *Actinophrys* passing into *Difflugia*.

Mr. Badcock said he had seen the paper, as well as some letters from Mr. Beaumont, who had also sent him two bottles of water, which he found to contain a number of naked *Amœbæ*, and also some of the testaceous forms, most of which, however, were empty. He had examined some of the specimens, but had not been able to follow out his observations, for various

reasons, the chief of which was that he did not possess the means adopted by Mr. Beaumont, who had a special slide made for the purpose, which he believed was a very good device. It embodied a method by which he was able to keep the water in constant circulation, and it rotated in a way that enabled him to make his observations continuously. He had asked Mr. Beaumont to come to the meeting to tell them more about the matter, but he was not able to do so. He promised, however, to exhibit his apparatus at a future meeting. In a further letter, Mr. Beaumont gave an account of an observation made of a *Euglena* found inside an *Actinophrys*, which, he said, had been taken in during the *Amœba* stage. In looking over some old notes he had found a drawing, made in March 1880, which seemed to correspond with one of the stages which Mr. Beaumont had called *Amœba actinophrya*. Mr. Beaumont had evidently worked very hard, and he thought great interest should be taken in what he was doing. By their next meeting he hoped to have some additional particulars.

Prof. Stewart thought there was very little doubt that these organisms existed under a variety of forms, and that there was nothing improbable in the idea that in *Difflugia* there may be an amœboid state, though there was nothing in the drawings which showed the characters of such special forms. That certain species of *Amœbæ* had more or less globose or spinous forms was also undoubted; but these were in structure very distinct from *Actinophrys*, in which one of the most marked features was the separation of the body into two layers, with rays of a somewhat more dense structure running from the central mass, and giving support to the outer layer. He did not recognize any such indications of complexity in Mr. Beaumont's drawings, and if these were absent, the organisms would not agree with the known characters of *Actinophrys*.

Prof. Bell referred, in connection with the paper, to Dr. Bastian's 'The Beginnings of Life.'

Mr. Hardy said that the second figure reminded him of an observation he once made of an *Actinophrys* being evolved from what is sometimes called *Acineta grandis*, which before separation would have a very similar appearance to this figure. This acinetan is developed from amœboid matter of varying shapes, which, to one not acquainted with their appearance, might be mistaken for *Amœba diffluens*. As *Arcella* and *Difflugia* may be developed from *A. diffluens*, the two *Amœbæ* might have been in the same trough, and the three forms are thus accounted for.

The President thought they were all prepared to admit that a fact must not be in any way disregarded because it was extraordinary, but he was quite convinced, after reading Dr. Bastian's book, that all such matters must be put into the hands of those who were specially skilled in determining the nature of such organisms. When Dr. Bastian's work was first issued, the reviewers considered it a very extraordinary book, and worthy of attention; but when experts examined the contents in detail, it was shown that the observations relied upon were false, and therefore the conclusions utterly failed. He did not pretend to say that the observations in the paper before them were false also; but he did not think the author could object to the same kind of tests being applied to them. They would be content to wait until next year, when the organisms could again be found, to see whether they were so or not.

The following Instruments, Objects, &c., were exhibited:—

Mr. W. Ball:—Photomicrographs.

Mr. Bolton:—*Œcistes Janus*.

Mr. Crisp:—(1) Nachet's Bi-ocular Microscope; (2) Nachet's Tri-ocular

Microscope and Prism; (3) Harting's Quadri-ocular Microscope; (4) Ahrens's Tri-ocular Microscope; (5) Reichert's Mechanical Stage.

Mr. Crouch:—Dr. Woodhead's Microscope, with large stage.
Mr. H. F. Dale:—Microtome, with treadle.
Mr. Enock:—Hessian Fly and its Parasite.
Mr. G. M. Giles:—Army Medical Microscope.
Dr. H. Van Heurck:—Photomicrographs of *Amphipleura pellucida.*
Col. O'Hara:—Photographs of *Surirella.*
Mr. Swift:—Platinized Microscope.

New Fellows:—The following were elected *Ordinary* Fellows:—
Messrs. J. G. Grenfell, F.G.S., W. D. Gunn, C. B. Holland, John Rutherford, J.P., and Edward F. Underwood, M.D.

MEETING OF 9TH NOVEMBER, 1887, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 12th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Nägeli, C., and S. Schwendener, The Microscope in Theory and Practice, translated from the German. xi. and 382 pp., 210 figs. (8vo, London, 1887)	*The Publishers.*

Dr. H. Van Heurck's letter was read, in which he expressed himself satisfied with the result of the discussion at the last meeting relative to his photomicrographs of *Amphipleura pellucida.*

Mr. E. M. Nelson said he had several matters to bring to the attention of the meeting. The first was a suggestion for supplying a want which many had felt of a really good achromatic single lens or loupe for microscopic purposes, of 1/2 in. focus. There were, of course, many such made, and he believed he had tried all, including the achromatics of Steinheil, but he had found them all open to one objection or another. He had, however, found that the want was met by a Seibert No. III. objective having its adapting screw removed. This, when used as a simple lens, formed the best loupe possible. The brasswork might be further turned down in a lathe, and the combination mounted like a Coddington.

Mr. Nelson further said that having lately obtained an improvement in optical power, he had been able to do a little more in the matter of resolution, and one of the first objects he tried was striped muscular fibre, which, as was well known, offered a good many complexities. In the early days of microscopy a muscular fibril used to be represented as a series of light and dark bands, the dark band being about twice the diameter of the white band. In 1853 Messrs. Huxley and Busk discovered a dark stripe in the middle of the bright band, and subsequently Hensen placed a similar darker stripe in the middle of the dark band. With his latest optical

appliances he had been able to see a faint white stripe on either side of Hensen's dark stripe. The sequence of the eight stripes is as follows:— A white stripe. Huxley and Busk's dark. White. Dark. Nelson's light. Hensen's dark. Nelson's light. Dark. He estimated the diameter of these stripes to be all equal. In a muscular fibril of a pig he found its diameter to be 1/11,500 in., and the length of the pattern 1/11,000 in. Therefore the diameter of the stripes may be estimated as about 1/88,000 in. Although he saw evidences of longitudinal breaking up, he could see nothing of Schäfer's beads. There were beads visible such as had been described by some observers, but he considered that these were the result of bad resolution causing the breaking up of the fibres. It was curious to note that with objects of this character some eyes seemed as if they always would see beads.

The third point noticed by Mr. Nelson was the note which appeared in the 'English Mechanic' of November 4th on Mr. Francis' method of improving definition of such an object as *Amphipleura pellucida* by using the analyser. He had tested the plan, and found that it did intensify the resolution in a very marked degree. It did not resolve anything which the objective could not resolve otherwise, but it certainly did strongly intensify it (*supra*, p. 1033).

Mr. Crisp said that the increased effect might be due, as was frequently the case, to an alteration in the intensity of the light. He should therefore like to see if the same effect could not be produced by altering the light in some other way than by using the analyser.

Mr. Nelson said he had tried altering the light, but it certainly had not the same effect.

Mr. Powell said he had also tested the use of the analyser, and found there could be no doubt as to the definition being improved by it; it was also certain that the same definition could not be obtained by reducing the light in other ways.

Mr. Nelson said he had tried all the most delicate tests, but he found an advantage was gained only by oblique light and in a particular direction.

Mr. Crisp inquired whether in the rotation of the analyser certain spectra were found to be shut off?

Mr. Nelson said the analyser was large enough to include the whole of the spectra in every position. He could, however, tell what was the best position by the strength of the green.

Mr. C. Beck suggested that a tourmaline should be tried, so as to see if the effect was exclusively due to polarization.

Mr. E. M. Nelson also exhibited and described a new portable Microscope made by Messrs. Powell and Lealand from his drawings (*supra*, p. 1013).

Mr. J. Mayall, jun., said he was glad that Mr. Nelson had interested himself in the design of so small an instrument, for a want had often been felt of such a Microscope. Generally speaking, a "miniature" Microscope was a mere toy. But here, he thought, Mr. Nelson had added substantially to the stock of working apparatus. The convenience of a good portable Microscope was unquestionable, and would doubtless be largely appreciated by microscopists. The arrangement of the lamp did not strike him favourably. He thought that if the instrument had to be handed round to a class or at a meeting, the lamp would be found inconvenient, if not dangerous. If he might make a suggestion for the improvement in the

mechanism of the new Microscope, it would be in the direction of strengthening some of the parts which seemed rather too weak. It was a vital point to have the optic axis exactly at right angles to the stage, but he feared the cross-arm support of the body-tube was very slight, and would be easily bent in the hurry of setting up or packing away. The attachment of the body-tube to the cross-arm seemed to him defective, and reminded him of some of the least successful of previous constructions. The want of a fine-adjustment might be met to a great extent by the application of a smooth-working draw-tube, as in Swift's Miniature Microscope.

The President said he must express his agreement with Mr. Mayall's suggestions for the improvement of the Microscope. Speaking after much experience in giving class demonstrations with the Microscope, he should consider a paraffin lamp was a dangerous thing to use in a class, in the manner shown, amongst a number of youths, who were not always particularly careful. He thought, if used in that way, some less dangerous oil or some other source of artificial light should be provided.

Mr. Nelson also exhibited and described the new photomicrographic camera, designed by Mr. C. L. Curties and himself. He also exhibited a negative of the proboscis of the blow-fly, which, he thought, would bear the closest examination (*supra*, p. 1025).

Prof. Crookshank said that he should like to examine the apparatus a little more closely after the meeting. He felt much obliged to Mr. Nelson for introducing a cheap and efficient method to their notice. He was himself more and more impressed with the value of photomicrography, and therefore welcomed every additional aid to its extension. So far as he could judge, this apparatus was simple, and enabled the process to be carried on with very little loss of time. This alone would be a great gain to pathologists who did not want to perform feats, but to get the greatest accuracy of detail recorded in as little time as possible. He thought that, especially with regard to bacteriology, the results obtained by photography had not been simply to obtain artistic pictures. Koch photographed the flagella of some of these minute organisms, and in this way obtained demonstrations of the existence of the flagella, which had not been believed in by many. He should like to say that at the Conversazione on the 23rd inst., he proposed to throw upon the screen a number of photographs of bacteria, to show that the results obtained by photography might be used for the purposes of teaching. He did not say that in all cases the results gave pictures as sharp as could be desired, but whilst it had been stated that one reason for disbelieving in the value of such researches was because they showed no morphological differences, he thought he might safely leave those to judge of the matter who would see what he proposed to show them on the 23rd.

Mr. Nelson further exhibited a new eye-piece which he had devised (*supra*, p. 928).

The President said that, as their time was already so far advanced, they must omit some of the minor matters on the programme for the evening, in order that they might hear Mr. Beaumont, who had come up to London to give them an account of his observations on the development of *Amœbæ*.

Mr. C. R. Beaumont then exhibited and described his new form of slide for observing living organisms, and read a paper in which he claimed to have observed the development of an *Amœba* into an *Actinophrys*, and then into a *Difflugia* and an *Arcella*.

The President said he was quite sure that the Fellows were indebted to Mr. Beaumont for taking the trouble of coming so far to present to them a detail of the facts as they appeared to him during the course of his observations. Whilst they should be most unwilling to do otherwise than give their best thanks to Mr. Beaumont for his paper, yet, for his own part at least, he should also be most unwilling to pronounce any opinion at present upon the subject, but thought rather that they should wait until the time of year arrived, when it would be possible to repeat the experiments in accordance with the ideas expressed by Mr. Beaumont. The statements made in his paper were so remarkable that it was not scepticism, but rather the exercise of a true scientific spirit to suspend judgment upon the question until it could be subjected to the test of experience. Those who had made observations upon minute forms, knew quite well, that though a slide might be good in all respects, yet the water from a still pond sometimes contained organisms which were capable of passing through the tube in their germ forms and of subsequently developing when the conditions were favourable. In one of the earlier volumes of the 'Monthly Microscopical Journal'—that for 1873—there occurred a description of one of the monads, in which exactly what Mr. Beaumont had stated appears to have been observed. In this case the monad, after moving about in the same manner, became amœboid. By-and-by two were seen to blend, and then, from this, spore-like bodies were seen to emerge. It was, he thought, quite possible that Mr. Beaumont might have interrupted this process, and also have introduced from extraneous sources that which might lead to considerable confusion. There were at least sufficient difficulties in the way to render it a matter for the exercise of caution. It should be distinctly borne in mind, however, that in this paper it was not the life-history of a single form which was described, but the transformation of one well-known form into another, and this again into a third and a fourth.

Mr. Beaumont, in reply to questions, said that the water which he used to fill up the slide was tap water; this was very good water in his part of the country. The water flowed from one reservoir to the other by the fall given to it by the inclination of the stage, and when it had all run through it was only necessary to rotate the stage, and the process would repeat itself from the other end.

Professor Bell, in reply to the President's request for his opinion, said that he had nothing to add to the remarks which had already been made by the President, but would merely repeat in other words that in these matters they must have the most absolute evidence of isolation in the case of the organisms under observation; if there was any doubt about that, of course the experiments must be repeated.

Mr. Beaumont said that the five ponds he had mentioned in his paper contained a large number of organisms, and he should be very glad to send up a supply to any one who wished to have some.

Mr. Badcock said, that at p. 225 of Mr. Saville Kent's work on Infusoria, there was an account which to a certain extent corroborated the observations which the President had just quoted from the Journal. In this he described and illustrated the direct metamorphosis of a flagellated zooid into an organism like *Actinophrys*. A similar life-history had also been worked out by Mr. Fullagar, who also described *Actinosphærium*. His own view was that Mr. Beaumont had, as he claimed, traced the life-history of *Amœba* from a flagellate monad to an ordinary *Amœba*, thence into *Actinophrys*, and thence again into *Difflugia* and *Arcella*, the tremulous sarcode bursting from the cyst and dispersing a number of granules. Now these granules, he presumed, would produce the original flagellate monad,

but this had to be proved. If they looked at the slide with a high power they would see that these granules were in motion, and it was very important that the rest of their history should be watched, and this link in the chain supplied. If that could be done, then he thought they had a very important discovery before them.

Mr. E. M. Nelson said he had very little knowledge of organisms of this class, but if any opinion from a brass-and-glass point of view was of any value, he might say that he was examining some monads in Scotland a short time ago, and was induced to watch them because they behaved in such a very extraordinary way, and in the course of his observations he saw the very same things take place which Mr. Beaumont had described—one of the organisms shot off its flagella, and then burst exactly in the same way.

Mr. C. Beck asked if any attempt had been made to isolate these organisms in the same way as had been done in the case of Bacteria?

The President said that, as already mentioned, observations exactly corresponding to those made by Mr. Nelson were not at all uncommon if made upon the organisms found in putrefactive fluids, but in order to be of value, they must be correlated. In the case before them it must be remembered that the claim was made that from a unicellular organism a more complex organism had directly arisen. The subject was very valuable as a basis of work, and no doubt there were some amongst them who would go very heartily into that work when Mr. Beaumont was again in a position to supply them with the material.

Mr. H. B. Brady's paper, "A Synopsis of the British Recent Foraminifera," was communicated to the meeting by Prof. Bell (*supra*, p. 872).

The President was sure it would be in full accordance with the feelings of the Fellows to accord their hearty thanks to Mr. Brady for this very valuable contribution to the literature on the subject. A Synopsis of British Foraminifera brought down to date was much required.

Mr. Crisp said he had been asked to mention to the meeting that Prof. Smith's collection of diatoms was in the hands of Dr. Maddox for disposal on behalf of the widow.

The President called attention to the Conversazione which had been arranged for the 23rd November, and said that they would no doubt be glad to notice that the usual programme was to be supplemented by an exhibition by Prof. Crookshank in his Bacteriological Laboratory, which would be of the greatest interest.

The following Instruments, Objects, &c., were exhibited:—

Mr. Beaumont:—(1) Life-slide; (2) Organisms illustrating his paper.

Mr. Bolton:—*Nitella* sp.?

Mr. Crisp:—Martin Microscope with fixed mirror.

Mr. Nelson:—(1) Portable Microscope; (2) Photomicrographic Apparatus with square Camera; (3) New Eye-piece; (4) Achromatic Loupe.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. A. J. Acheson, Ph.D., M.D., F. T. Andrews, Ph.D., M.D., J. W. Blagg, Edward T. Browne, C. S. Jeaffreson, F.R.C.S., Andrew Pringle, and Rev. C. H. Rowley.

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